SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 14.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 14.

NEW-YORK, APRIL 1, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

SMALL STEAM YACHTS.

WE give drawings herewith of two examples of small steam yachts, the Black Hawk and the Continental.

The Black Hawk, owned by Mr. G. Chase, of this city, 107th street, East River, merits notice as a boat of small dimensions, but fast and serviceable. The keel length is 15 feet 10 inches; beam, 57 inches. Draught, light; at bow, 13½ inches; at stern, 16 inches. The boiler is 20 inches in diameter and 32½ inches high, containing 42 tubes, and a fire-box 16 inches high above the grate. The stroke of engine is 4 inches; diameter of piston, 4½ inches; nominal horse-power, 3; usual steam pressure, from 100 to 130 pounds. The feed-water is heated by a copper coil, conveying the exhaust steam through the feed-box to the flue. There is a coupling to allow the pump to work independently of the screw.

The propeller is three-bladed, 21 inches diameter, pitch about 3 feet 6 inches. This screw was found best after using two-bladed and four-bladed screws. Coke is generally used, of which 3½ bushels are consumed in a day's steaming.

Fresh water, carried in tanks, was formerly used, of which 32 gallons per hour were evaporated. Although salt water is now substituted to avoid carrying the weight of the fresh water, the boiler works quite free from scales.

The speed of this neat little boat—seven miles per hour—is chiefly due to its lightness.

The frames are 6 inches apart, of oak, ⅞ inch thick. The planking inside and out is ⅜ inch cedar. The propeller and shaft are of steel, to save weight; the shaft ¾ inch diameter. The engine weighs 400 pounds, the boiler 300. Our elevation and cross-section are from drawings by Mr. H. Y. Beach; the perspective view by H. E. Mead.

STEAM YACHT CONTINENTAL.

(See illustration on next page.)

WE illustrate, from drawings furnished by the builders, the high-speed yacht Continental, built by Messrs. Holmes, Shaw, Brown & Co., Bordentown, N. J., who are making a specialty of this class of pleasure-craft, and have had a most remarkable success with this boat. To them we are indebted for the following particulars:

The Continental is 50 feet over all, 6' 6" beam by 3' 6" depth, and is built of iron. Her structure seems the perfection of lightness with strength, which is apparently one of the leading features of her design. The hull has an air-tight compartment at each end, and is divided into five water-tight compartments by four iron bulkheads, thus giving her increased safety properties. By reference to the illustration, it will be seen that one of the chief peculiarities of this boat is in the fact that half the diameter of the propeller revolves below the keel, thus being in solid water; this is an advantage of considerable moment, and when taken in connection with the very light structure of hull and engines, and the excellence of model, accounts for the success attained. High speed has been supposed to dwell only where the large structure was to be found, but Messrs. Holmes, Shaw, Brown & Co. say no! one can run a 50-ft. boat as fast as a vessel 150 ft., and, as in the Continental, they embrace a light structure, a suitable model, place the propeller in the most advantageous place to secure solid water, carry high steam, and run their engines at a very high piston-speed, or, in other words, the power employed is greatly in excess of the weight or displacement. For instance, some large fast vessels have an indicated horse-power of 3000, driving 6000 tons of displacement, whereas the Continental has 74 effective horse-power, driving 6.5 tons of displacement, a proportion of .5 to 1 against 11.31 to 1, which is greatly to the advantage of the latter.

STEAM YACHT BLACK HAWK.

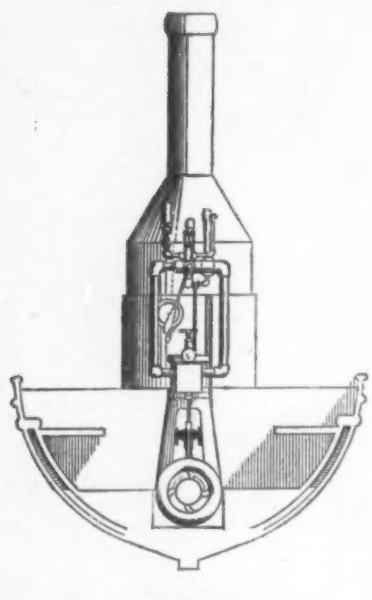
The Continental has a very handsome hardwood cabin, elegantly upholstered, and decorated suitably with gilt mouldings. The house extends over the engine-room, so that they are protected from the weather. The machinery is composed of double inverted cylinders, 6" diameter by 8" stroke, carried upon six turned steel columns; the piston-rods and valve-stems are of steel, and the piston-rod guides are the slipper side. The crank-shaft is of steel, and is a very elaborate piece of work, as the counterbalances are of same piece as cranks, and are adjusted to a balance. The boiler is of the locomotive type, tested to 140 lbs. steam, and has 4 square feet grate surface and 75 1½ tubes. The Continental attained a speed of 17.9 miles over an eight-mile run on her trial trip with 100 lbs. steam; but since she has been running and got her machinery smooth and boiler in better steaming trim, she has run from Greenwich Point to Bridesburg, on the Delaware, a distance of 11 miles (carefully measured on chart), in thirty minutes, carrying from 120 to 130 lbs. steam, and making 520 turns per minute. This speed has never been equalled in a small boat for so great a distance, and gives the Continental the enviable reputation of standing at the head of the steam yacht-fleet for speed. We must thank Messrs. Holmes, Shaw, Brown & Co. for the working drawings whereby we obtained the wood-cuts presented, which very clearly illustrate the particular points of this handsome yacht.

THE STEAM YACHT BLACK HAWK.

TRIAL OF MAKAROFF MATS.

A SHORT time since experiments were made at the Keyham Yard in one of the caissons with the Makaroff safety mat for stopping leaks in vessels, and afterwards with a mat manufactured at the Dockyard. The caisson did not afford facilities for a fair testing of the mats, and experiments were conducted on board Her Majesty's ship Northumberland, lying in the South Basin. The Government mat is about 12 feet square, and is formed of three thicknesses of canvas. The first piece of this canvas is thrummed, the second oiled and dried, and the third or outside sheet painted and roped around its edges. The mat on the inside is thickly fitted with beckets, so that with the hooks supplied for the purpose it may be easily and firmly secured, and when in its place this mat costs in manufacture, it is said, about £9. The Makaroff, which is a Russian mat, is about 14 feet square, and involves a considerable outlay. At the first trials the same difficulty was experienced with both mats to get them over the hole. The first mat experimented with was the Government one. Arrangements had been made, and the ropes which were attached to the bottom of the mat had been passed under the keel of the Northumberland, the mat hanging over the side of the vessel. All being ready the main sluice-valve was opened, and the mat lowered; but unfortunately this experiment was not successful, as the corner of the mat entered the aperture, and the water continued to rush in for half a minute, and until the valve was closed again. The second experiment, with the same mat, was, however, more successful. The valve was once more opened, but previous to this the mat was lowered directly over it. In about one minute from the time the water began to pour in, it commenced diminishing, and as the mat fitted into the aperture, it still further decreased, until in about two minutes the amount of water which flowed in was exceedingly small. It was thus seen that when the mat was placed directly over the hole previous to the valve being opened, the weight of the water forced it against the aperture, thus obtaining the desired effect. The great difficulty apparent from all the experiments was in lowering the mat so as to get it to fit exactly over the hole after the valve was opened and the water was rushing in. At the conclusion of the two trials with the Government mat there was 2 feet 6 inches water in the bilge. This, however, did not enter further than the engine-room compartment. The Makaroff invention was then tried, the valve was opened, and the mat lowered. In half a minute the great rush of water decreased somewhat, but remained still great, and as it had not further diminished, the valve, having been open two minutes, was closed. It was found that in this, as in the former experiment with the Govern-

ment mat, it had not been placed completely over the hole, and therefore, of course, could not possibly keep the water out. A further trial was then made with the Makaroff. This time the mat was lowered over the sluice before the valve was opened, and it answered in every respect, completely stopping the water. After being open two minutes, the valve was again closed, and it was found that the water had increased to 4 feet 2 inches in the engine-room. It will thus be seen that in the experiment with the Government mat 2 feet 6 inches of water were admitted, while the Makaroff admitted only 1 foot 8 inches. The hole was 13 inches wide and 2 feet long, admitting water equal to a pipe 2 feet 3 inches in diameter. Whether the invention would prove entirely successful in case it were required suddenly at sea is a question.—*London Times.*



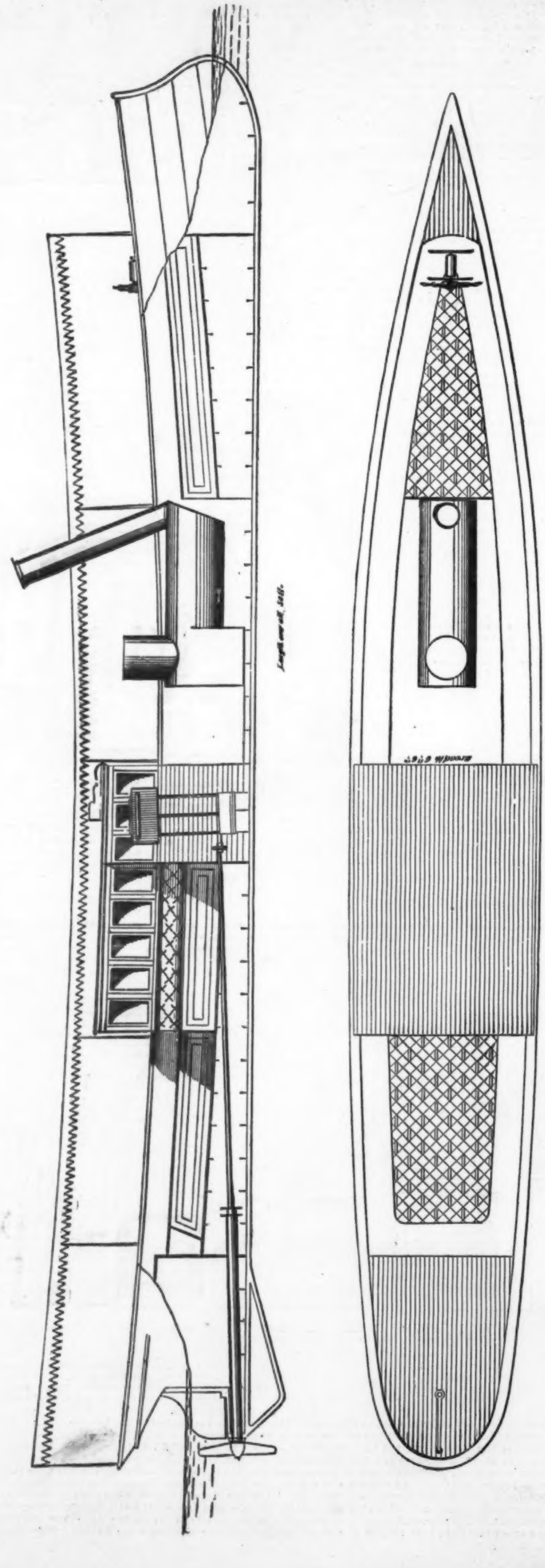
Scale of Feet.

STEAM YACHT BLACK HAWK.—(*See preceding page*

THE AZORES BREAKWATER.

One of the greatest works ever undertaken by the St. Michael's people, and which reflects the highest credit upon them, is the construction of the artificial harbor of refuge opposite Ponta Delgada. The works have already been going on for twelve years, and will be another ten years yet before they are completed. The advantage of this harbor can scarcely be overrated, for here ships of almost any size may take shelter from the awful storms of the Atlantic. There is a floating dry-dock for ships requiring repairs, while all kinds of provisions may be bought by vessels at very reasonable rates. The construction of this harbor has been one of such difficulty and magnitude that it is worthy of more than a passing notice. The principal work will consist of a mole attached to the land in natural rocks crowned by a breakwater like that at Holyhead. This will be 860 metres in length at low water, and will shelter ships from the winds that blow from the south-east and west by south. The harbor being situated on the south side of the island in a bay is protected by the land from all other winds. A quay is to be constructed along the inside face of the mole, and this will enable ships to load and discharge with safety and convenience. At present the mole is only built about two thirds of its length, but it will shelter 33 ships, including three or four steamers of large tonnage. The islands of the Azores offer, by their position in the middle of the North Atlantic, at a nearly equal distance from Europe, Africa, and America, an advantage to transatlantic navigators that has been long acknowledged. But until the artificial harbor of Ponta Delgada was begun, there was no secure shelter in any of the islands for shipping. As it is probable a submarine cable will shortly be landed at St. Michael's from England, so as to connect the two places by telegraph, ships will enjoy the advantage of being able to call at St. Michael's for refreshments, and also to receive orders from England as to their destination. An idea may be formed of the assistance this harbor is calculated to give to vessels in distress when it is considered that 8000 ships of nearly 4,000,000 tonnage are employed by England alone in the transatlantic trade. At least 2 per cent of these—that is to say, 160 vessels—suffer heavy damages in a radius of ten degrees around the Azores.

As one looks at this breakwater and watches the angry sea that dashes furiously against the barrier, it is impossible to suppress a feeling of admiration for the skill and perseverance that have so far triumphed over the tremendous forces of wind and water. The stone has had to be placed literally in the bed of the Atlantic; and some idea may be formed of the work when it is stated that it is estimated that the quantity of stone required to complete the work is 2,341,104 tons, and 1,833,498 tons have already been placed. The material used is the lava stone, which is quarried some little distance from the town, and after being placed in position, it is further strengthened by massive baulks of timber, bolted together by huge bars of iron. Not very long ago, during a heavy gale from the south-east, a portion of the breakwater was washed in; and so terrible was the force of the rollers that the timber supports were snapped like matches. The bars of iron were twisted as if they had been wire, and ponderous blocks of stone, weighing many tons, were flung about like pebbles. This mischance, however, was not without its advantages, inasmuch as the stone that was washed down fell inside, and formed a more solid foundation for the superstructure. The damage is now almost entirely repaired. The estimated cost of the whole work is $2,676,000, and 2-5ths of this sum has already been expended. The sum is raised by a tax upon every box of oranges shipped, and by harbor dues, and one and a half per cent *ad valorem* on exports and imports. The plans for the breakwater and mole were drawn up by Sir John Rennie and Mr. Tucker, and carried out under the superintendence of the former eminent engineer.



STEAM YACHT CONTINENTAL, BY HOLMES, SHAW, BROWN & CO.—(*See preceding page.*)

ALLUVIAL BASIN OF THE MISSISSIPPI RIVER.

To the Editor of the Scientific American :

My attention has been called to a review of the report of the United States Levee Commission, signed by Mr. James B. Eads, and contained in your SUPPLEMENT, No. 11, for the week ending March 11th, 1876. I have neither leisure nor inclination to engage in a newspaper controversy on the subject of the reclamation of the alluvial region of the Mississippi from overflow, and shall therefore entirely refrain from comment upon the theoretical views of Mr. Eads where they differ from those of the Commission and of the Chief of Engineers. With many of your readers, these matters, like other professional questions, will be decided by their estimate of the weight of authority, rather than by argument; while engineers will carefully consider all the available evidence for themselves. Nothing that could be said here would influence the views of either class respecting mere theory.

So far as the facts are concerned the case is different, and Mr. Eads has fallen into some serious errors of this nature, two or three instances of which I propose to point out.

First. In regard to the blue clay, Mr. Eads states: . . . "We thus have one definitely fixed location in the river," the Bonnet Carré Crevasse, "and I believe the only one definitely stated, where this clay can be found, according to the testimony of those who declare that it does really exist." . . . "I have myself sounded almost every bend in the river from St. Louis to New-Orleans, and have been on the river bottom in the diving-bell in some part or other of every fifty miles of that distance, yet I have never met with any clay more unyielding than the common blue clay of its bed and banks."

It is nowhere stated, either by the Commission or in the *Physics and Hydraulics of the Mississippi*, that the blue clay which constitutes "the real bed upon which rest the shifting sand-bars and mud-banks made by local causes" is different from the "common blue clay of its beds and banks"—but simply that it is unlike its "present deposits," and that it does strongly resist the wear of the current. An instance in point is cited by the Commission—namely, the upper mouth of the Atchafalaya, where the current is very strong, and where a careful resounding of old lines after the lapse of eight years showed no appreciable erosion of the bed. *The Physics and Hydraulics of the Mississippi* names many localities where this clay was found in the bed of the river. I quote from page 102 a single example: "If the bottom were formed of alluvion it would be comparatively smooth, like a sand-bar or willow batture. In realty, it is very rough, being in many places full of blue-clay ridges and lumps, some of them many feet in height." "In three instances—once at Bonnet Carré," not at the Crevasse, "once at Natchez, and once at Randolph—the lead was lost while being drawn up after the sounding by the chain striking one of these clay lumps as the boat drifted down stream. Large quantities of the clay were found adhering to the broken end of the chain, at a distance, in one case, of more than thirty feet above the lead." That some gradual action is had, even upon a material so resisting as this, is not doubted; but that by any device a great flood can be caused to wash out a channel in it instead of raising the level of the water surface is not believed by the Commission or by the Chief of Engineers.

Second. Respecting the amount of sediment carried in suspension by the water, Mr. Eads states: . . . "The Chief of Engineers U. S. A., in one of his several jetty papers in 1874, referred to these observations at Columbus and Carrollton, which were so convincing to him that he then declared it was unnecessary to pursue the subject further." . . . . "In answer to this reference I replied in 1874, that the quantity of matter held in suspension is modified by the *depth* of the stream, and that the element of depth was totally ignored in these observations. Hence they are unintelligible, and in spite of their accuracy, which I never doubted, they are without value." . . . "The Chief of Engineers U. S. A., however, in one of his four jetty papers published in his recent official report (1875), returns to the subject, and reiterates the Delta Survey theory more emphatically than ever. But he advances no new proof, and the long series of exact measurements at Columbus and Carrollton alone are still deemed so conclusive on the subject that he now declares it will not be considered again," from which I infer that the proof in support of his proposition is exhausted. The fact that in these exact measurements the element of depth was totally neglected, although exposed eighteen months ago, is treated with perfect silence.

It is probable that the Chief of Engineers does not regard it as a part of his duty to reiterate facts once plainly stated in an official report, or to correct gross errors made by writers in commenting thereon. At any rate he appears not to have done so in this instance. On page 138, *Physics and Hydraulics of the Mississippi*, is a table giving the results of a year's observations at Carrollton, and showing the weekly amount of sediment collected at three positions. "The stations were situated opposite the velocity base; one about 300 feet from the east bank, the next in the middle of the river, and the other about 400 feet from the west bank. The high water depths at these stations were 100, 100, and 40 feet respectively. Samples of water were collected daily (Sundays excepted) at surface, mid-depth and bottom at the first two stations; and at surface and bottom at the third."

The aggregates for the year were as follows, the figures representing the grammes of dry sediment contained in 31,-200 grammes of river water:

	Surface.	Mid-depth.	Bottom.
1st Position	15.202	17,552	17,880
2d Position	15,156	18,977	19,538
3d Position	13,846		20,070

The following diagram, a tracing from Plate XII., shows the relation between the mean velocity and the grand mean of these observations week by week, and sufficiently justifies the real views expressed by the Commission and by the Chief of Engineers, although not as they are misstated by Mr. Eads.

Third. In respect to the contraction of the channel below the site of the Bonnet Carré crevasse, Mr. Eads states: . . . "We are assured by the Chief of Engineers, U. S. A., that the subject was 'carefully investigated,' and that 'it was found there had been no deposit whatever below Bonnet Carré crevasse, and that the bottom of the river there was of hard blue clay of older formation than alluvion, and that the cross-section had unquestionably remained unchanged.' These statements are made in the absence of all measurements *before* the crevasse occurred, and, therefore, in the absence of any *positive* proof of the fact asserted."

"The Commission publish tables of several measurements of the river section at this locality, made by Humphreys and Abbot, Forshey, Ellet and Bayley, and declare that 'the surprising accordance' in them 'puts this vexed question forever at rest,' as if, forsooth, they should not accord, when each measurement was made under similar conditions."

The table referred to is the following:

Comparison of soundings near Bonnet Carré crevasse of 1850.

Grouping of sections.	Authority.	When made.	High-water dimensions.		
			Year.	Width.	Area.
				Feet.	*Sq. ft.*
Above crevasse (Bayley section between other two which were 1000 feet apart)	H. and A. No. 37	June, 1851	1851	3,100	263,000
	Bayley No. 1	Sept., 1874	1874	3,120	247,710
	H. and A. No. 38	June, 1851	1851	3,500	237,000
Upper end of crevasse of 1850	Forshey	July, 1850	1849	3,500	216.300
	Ellet	Feb., 1851	1849	....	200,000
	H. and A. No. 39	June, 1851	1851	3,490	208,100
	H. and A. No. 40	Feb., 1859	1858	3,480	207,822
	Bayley No. 2	Sept., 1874	1874	3,210	223,295
Near middle of crevasse of 1850	H. and A. No. 41	June, 1851	1851	3,380	168,000
	Bayley No. 3	Sept., 1874	1874	3,700	172,300
Lower end of crevasse of 1850	Forshey	July, 1850	1849	....	147,500
	Ellet	Feb., 1851	1849	....	154,000
	H. and A. No. 42	Feb., 1859	1858	3,200	154,084
	H. and A. No. 43	June, 1851	1851	3,145	163,500
	Bayley No. 4	Sept., 1874	1874	3,320	151,797
	Bayley No. 5	Sept., 1874	1874	3,430	162,029

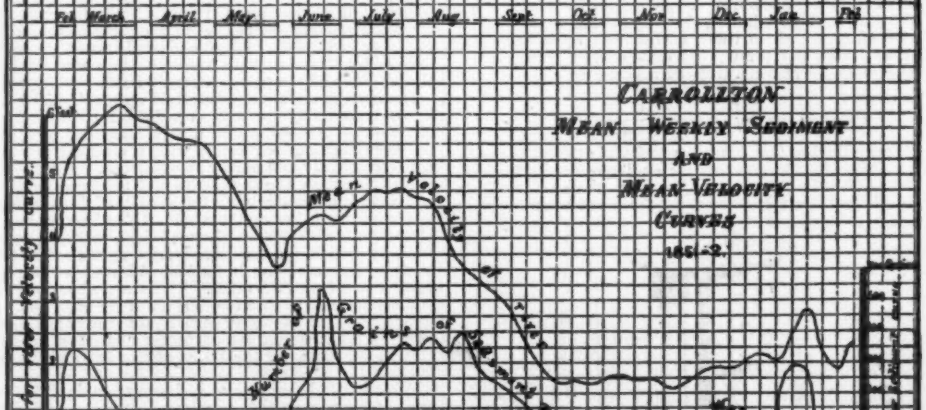
Mr. Eads states vaguely that "three crevasses have occurred at this point in the last 25 or 30 years"—but to properly weigh this evidence a little more precision is needful. The first crevasse occurred on December 29th, 1849, and continued to flow for about six months. Professor Forshey made his survey in July 1850. The break was repaired and resisted the great flood of 1851. Soundings by Ellet in February, 1851, just before this flood and by the Delta Survey in June, 1851, after the river had fallen showed that no washing out or change of the bar occurred. The levee remained good and in February, 1859, another measurement by Delta Survey showed that the current during the eight intervening years, including the great flood of 1858, had made no change. The levee broke for the second time on April 19th, 1859, and was rebuilt. The third break occurred on April 11th, 1874—M., Bayley's soundings were made in the September following—and he found the same cross-section as all the preceding surveys had shown. These facts prove that the measurements were not made under "similar conditions," and that they amply justify the statements of the Commission and of the Chief of Engineers.

I pass over Mr. Eads' remarks upon the method by which the Commission computed the heights needful to be given to the levees, because their injustice and entire inappreciability are manifest to any one who has read the report.

Other instances of errors of facts might readily be pointed out in this review, but the foregoing sufficiently show that Mr. Eads' professional labors have prevented him from studying the subject so thoroughly as might be desirable in attacking the conclusions formed after due deliberation by engineers specially charged with this duty.

HENRY L. ABBOT,
Major of Engineers, Bvt. Brig. Gen.

WILLETS POINT, N. Y., March 6, 1876.



THE EMBANKMENTS OF THE MISSISSIPPI RIVER.

To the Editor of the Scientific American :

The writer's attention was called to the article in your SUPPLEMENT, last issue, by the great Engineer, Eads (see page 255, "Principles of Geology," by Lyell, 9th edition). "*Artificial Embankments of Italian Rivers.*—To check these and similar aberrations, a general system of embankment has been adopted, and the Po, Adige, and almost all their tributaries, are now confined between high artificial banks. The increased velocity acquired by streams thus closed in enables them to convey a much larger portion of foreign matter to the sea; and consequently the deltas of the Po and Adige have gained far more rapidly on the Adriatic since the practice of embankment became almost universal. But, although more sediment is borne to the sea, part of the sand and mud which in the natural state of things would be spread out by annual inundations over the plain, now subsides in the bottom of the river-channels; and their capacity being thereby diminished, it is necessary, in order to prevent inundations in the following spring, to extract matter from the bed, and to add it to the banks of the river." Page 256. "The practice of embankment was adopted on some of the Italian rivers as early as the thirteenth century; and Dante, writing in the beginning of the fourteenth, describes, in the seventh circle of hell, a rivulet of tears separated from a burning sandy desert by embankments, 'like those which, between Ghent and Bruges, were raised against the ocean, or those which the Paduans had erected along the Brenta, to defend their villas on the melting of the Alpine snows.'" O. P. STEVENS.

CLEVELAND, O.

A MODEL ASSAY-OFFICE.

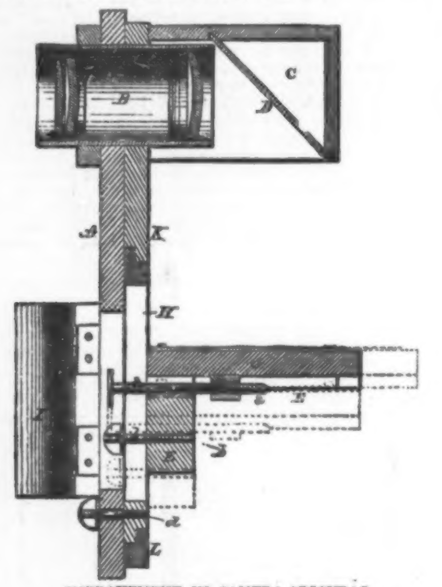
THE destruction of the old assay-office by fire and the steady increase of the monthly yield of the Consolidated Virginia mine, with the prospect in a very short time of the California doubling the amount of assaying to be done and the bullion to be handled, has caused Messrs. Mackay & Fair to erect an assay-office and bullion reduction-works commensurate in fitness and size with the immensity of their business, and which, without doubt, is superior to any private assay-office on the globe. A peep at the inside and its appointments may not be uninteresting to our readers. The office is situated on the south side and immediately adjoining the hoisting works of the Consolidated Virginia. The building faces on F street, is 45 feet in width, 85 feet in length, and two stories in height. The lower story is 12 feet in height, and contains the assaying and smelting departments. The upper story will be divided into offices for the superintendent of the mines and the chief secretary and his assistants. Running the whole length of the building on the front is a platform just the height of a wagon-bed, greatly facilitating the loading and unloading of bullion. Built through the centre on the ground floor, running the entire length of the building, and back again, is a double flue, with a chamber two and a half by five feet in size, and a total length of 170 feet before reaching the south end of the building, where it ends in a huge brick smoke-stack, 40 feet in height, on top of which is again placed an iron stack 50 feet in height. This flue is sheeted in the bottom with iron, and is built on the best improved plan for saving the silver which is constantly being carried off by the fumes and vapors while smelting. Extending across the building 30 feet from the north end is a hall 10 feet in width, which is to be furnished with a car and track for conveying the bullion to and from the assay and smelting-rooms. The first room in the north-east corner is 12 x 15 feet in size, and will be used for the assay weigh-room. Adjoining this on the south is the humid assay-room, 12 x 15 feet also. In the centre of the building, on the west of these, is the clerk's office and calculating-room, 12 x 24 feet in size. West of these, in the northwest corner, is the laboratory and cupelling room, 18 x 24 feet in size, from which, crossing the hall, the visitor enters the ore assay weigh-room, south of and adjoining which is the ore assay furnace room. The southwest corner room is occupied as a store-room for supplies and a bath-room furnished with hot and cold water. The melting room has no ceiling, the two stories being open to the roof. It is situated in the southwest corner of the building, and is 22 x 50 ft. in size. It contains eight furnaces, built on the best improved plans, with grate-bars that can be removed or adjusted in a moment, when necessary. Its capacity is estimated at 2500 pounds of bullion, avoirdupois, at a single melt. The draught of the furnaces is strong enough to instantly snuff out a candle. The office is furnished with two ore assay, one cupelling, and two muffle furnaces. The ore assay and bullion departments are kept entirely separate in all their workings. On the first floor is a huge vault for the bullion, while on the upper floor is another vault for the valuable books and papers of the superintendent and secretary. The building is furnished throughout with glass-doors, so that it is well lighted in the day-time, while at night it is furnished with gas-jets in every room. The assaying and smelting capacity of the entire works is estimated at from $5,000,000 to $6,000,000 of bullion per month.—*Gold Hill News.*

IMPROVEMENT IN CAMERA-OBSCURAS.

By T. A. Kellett, Wells, Minn.

Consists in an adjustable table, in combination with a reflector and camera, by which a small picture placed on the table can be adjusted in suitable position under the reflector to be presented to the camera, so as to obtain an image of the picture direct and enlarged to any required size for painting on a canvas behind the camera by the aid of natural or artificial light.

A, a board or plate of any suitable dimensions, through the upper part of which is passed a camera, B. The outer or front part of this camera is covered by a hood *C*, in which is a reflector D, standing at an angle of forty-five degrees with the camera. Below the hood and camera is an adjustable table G, upon which the photograph is to be placed. This table is parallel with the axis of the camera-tube, and at an angle of forty-five degrees with the reflector. It is adjusted horizontally out and in on a support E by means of a screw *a*, and the support E is adjusted vertically up and down in a gate H, and held at any point desired thereon by a set-screw *b*. The gate H is adjusted laterally in guides K and L on the front of the plate A, and held by a set-screw *d*. In the plate, A is a mortise covered by a door I, through which access is had to the set-screws *a* and *b*, as shown.



IMPROVEMENT IN CAMERA-OBSCURAS.

The photograph or other picture is to be secured to the table G, so that it will present a plane surface to the reflector. Then, to obtain a life-sized image of this photograph, adjust the table in the centre of the instrument by means of the set-screw *d*. Then, by means of the set-screw *b*, adjust the support or bracket E, so that the table will be three and one half inches below the hood containing the reflector, and then draw the table back by means of the set-screw *a* until it touches the gate or slide H.

The instrument thus arranged is placed in a mortise made in a dark shutter in a window upon which the sun shines, so that the sunshine may fall directly on the photograph.

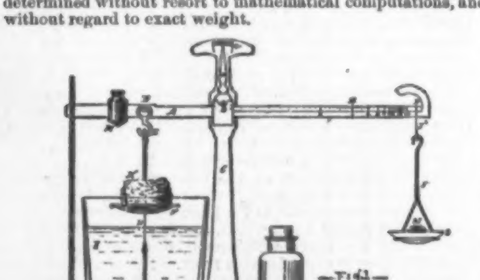
A painter's canvas, sheet of drawing-board, or white screen of the desired size is placed in the room, so that its plane shall be perpendicular to the axis of the camera-tube, its centre on a level with the tube, and about forty-two and one half inches from the back lens of the same. Now, exclude all light from the room, except that admitted through the lens, when a life-sized image of the photograph will be seen on the canvas.

With a drawing or crayon pencil, an outline of the image may be drawn by tracing the prominent lines as they appear on the canvas.

NEW SPECIFIC-GRAVITY SCALES.

By R. Parish, Worcester, Mass.

The object is to provide an instrument for use in chemical laboratories or mineralogical field-work, by the aid of which the specific gravities of common minerals and other solid substances heavier than water can be quickly and conveniently determined without resort to mathematical computations, and without regard to exact weight.



NEW SPECIFIC-GRAVITY SCALES.

The instrument is adjusted to accurate balance with the counterpoise J and its loop J¹ removed from the beam A, but with the double baskets F G in position, and the vessel I supplied with water, as indicated. In determining specific gravities, the mineral K, or other solid to be tested, is placed in the basket F, and the pan-holder or counterpoise J is adjusted to the position P, established at a convenient distance from the fulcrum B, and marking the extreme working length of the lever-arm. One or more of the pans L are placed upon the holder J to counterbalance the weight of the mineral, and a sufficient quantity of the granulated copper or sand is placed in the pan to cause the beam A to assume a horizontal position, or to stand in perfect equilibrium. The mineral K is then removed from the upper basket F, and placed in the lower basket G, where it is submerged in the water contained in vessel I. The counterpoise J, with its load of pans and granular material, is then moved along the beam A toward the fulcrum B to a position S, where it just counterbalances the submerged mineral. This position S corresponds with the specific gravity of the mineral, and the amount being indicated by the graduated scale can be read off direct, thus giving at a glance the correct specific gravity without regard to the weight or quantity of the mineral K or other substance under test.

The indicating-scale B P is constructed or graduated in accordance with the following considerations—namely, let x represent the exact weight of the counterpoise; then,

$$\frac{x.\text{BP}}{\text{BD}} = \text{weight of K in air, (1).}$$

$$\text{Also, } \frac{x.\text{BS}}{\text{BD}} = \text{weight of K in water, (2).}$$

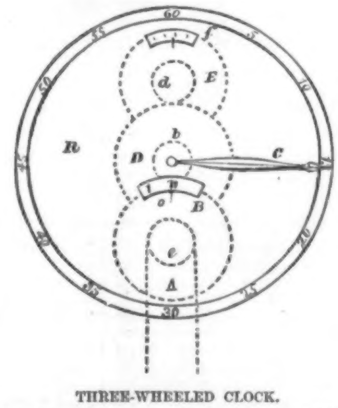
$$(1)-(2)\left(i.e.,\ \frac{x.\text{BP}}{\text{BD}} - \frac{x.\text{BS}}{\text{BD}}\right) = \frac{x.\text{PS}}{\text{BD}} = \text{weight of water displaced, (3).}$$

$$(1) \div (3)\left(i.e.,\ \frac{x.\text{BP}}{\text{BD}} \div \frac{x.\text{PS}}{\text{BD}}\right) = \frac{\text{BP}}{\text{PS}} = \text{specific gravity of K.}$$

Hence the specific gravity is known if the ratio $\frac{\text{BP}}{\text{PS}}$ is known. This ratio is indicated upon the arm B P for as many points as may be desired. The peculiar scale thus constructed, and its application, constitutes one chief essential feature of the instrument.

THREE-WHEELED CLOCK.

The following, taken from an old publication, may be a novelty to some of our amateur clock-makers. The mechanism is very simple, and easily fitted up, as it has only three wheels and two pinions altogether. R is the dial-plate; A is a wheel of 120 teeth, and on it is a brass plate, on which are engraved or painted the twelve hours with their halves and quarters. This plate turns round once in 12 hours. It is seen through an opening in the dial-plate at B; *c* is the pulley for the weight; *b* is a pinion of 10 teeth; on its axis is fixed the minute-hand; C, which goes round the large circle of 60 minutes whilst the hour-plate, B, shifts one hour under the fixed index, *o*; D, is a wheel of 120 teeth, fixed on the axis of the minute-hand, turning a pinion, *d*, of 6 teeth; on its axis is the wheel E, of 90 teeth that keeps the pendulum in motion, vibrating seconds. As this wheel moves round once in three minutes, the seconds are numbered 10, 20, 30, 40, 50, 60, three times successively on a brass ring fixed to it, seen at *f*, through the dial-plate.

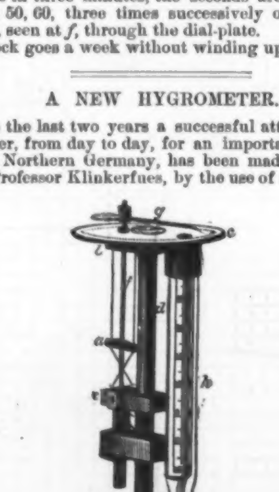


THREE-WHEELED CLOCK.

This clock goes a week without winding up.

A NEW HYGROMETER.

During the last two years a successful attempt to predict the weather, from day to day, for an important agricultural district in Northern Germany, has been made by the distinguished Professor Klinkerfues, by the use of a new hygrometer, especially invented by the learned professor himself, for this purpose. The new hygrometer gives at once the relative humidity and the dew-point, and it does this without calculation, and without the use of tables.



A NEW HYGROMETER.

The construction is as follows: The small brass wire, *a*, is is suspended by a loop of human hair from the block of brass *b*, much in the same way as the magnet of a bifilar magnetometer. There is another loop of hair passing through *a* from below, and connecting it with the block *c*, but in such a manner that there is half a turn of twist in the two loops of hair. *b* and *c* are firmly secured to the iron standard *d*, which supports the dial *e*. Attached to *a* is the wire *f*, carrying the index *g*, which indicates the degree of relative humidity on the dial *e*; *h* is a thermometer, giving the temperature of the surrounding air. The block of wood *i*, forming the base of the instrument, has a circular scale upon it marked with percentages from 2 to 100; another circular scale is attached to the piece *j*, into which *d* is screwed. This scale can be rotated upon the lower one. It is marked with temperatures—in the German instruments, from —15° to +40° Reaumur, or from —1°.75 to +122° Fahrenheit. These two scales form a sliding-rule, which gives the dew-point as follows: The line corresponding to 100 per cent on the outer scale is brought opposite to the division expressing the temperature of the air on the inner circle; then on the inner scale the dew-point will be found opposite to the reading for the relative humidity taken on the outer scale. By means of a few extra divisions on the outer circle and the help of a small table, the weight of aqueous vapor contained in a given volume of the surrounding air can be found. The additional divisions are marked as fictitious percentages beyond 100. Let t be the temperature of the air, and τ that of the dew-point. If now the fictitious percentage, $100 + t - \tau$, be set to the temperature of the air, the division representing the relative humidity will indicate a temperature T on the inner scale, at which a volume of air saturated with moisture, contains as much aqueous vapor as an equal volume of air at the temperature t. By consulting a table giving the maximum quantity of moisture which air can contain at various temperatures, the quantity of moisture actually contained in the air experimented on will be found opposite T.—*English Mechanic.*

[American Architect and Building News.]

FRENCH CONSTRUCTION.

I have seen floors laid with rolled I beams, a fraction over four inches deep, and so light that a man would take up one ten feet long and carry it into the building on his shoulder.

Some of the floors had only the hooked iron bridging, which was of square rods, about ½" x ½", omitting the longitudinal rods, and the plaster concrete between the beams seemed to stay in place with only this assistance. I have seen also a floor of oak beams, about 3" by 10" with plaster concrete between. In this case, there were probably iron rods, similar to those used with the iron beams, although I could not find any trace of them.

The concrete flooring is finished with tiles, or sleepers are set in the plaster, and a single flooring of oak is laid on them in the following manner:

The oak stock is delivered in various lengths, tongued and grooved, about an inch thick and three inches wide. The workman cuts off, with a mitre at each end, a piece long enough to go diagonally, at an angle of 45°, from the centre of one sleeper to the centre of the next. The sleepers are about two and a half feet on centres, and the pieces thus about 43 inches long, allowing half an inch extra at one end. He then marks carefully on the piece the exact length, and out of the extra half-inch or so he cuts with a common handsaw a tongue at one end, and in the same manner a groove at the other, and, fitting this to the last piece, nails it, and proceeds in the same manner with the next, which is reversed, so as to form a herring-bone pattern all over the floor.

The rapidity with which all this is done is more wonderful than the accuracy, and the floors require plenty of smoothing.

Perhaps the most remarkable thing in Parisian building is the extent to which plaster is used. The beginning of a job seems to be to provide a room, and fill it two or three feet deep with plaster, ground only about as fine as meal. Then, with a further supply of fine plaster in bags, operations can begin.

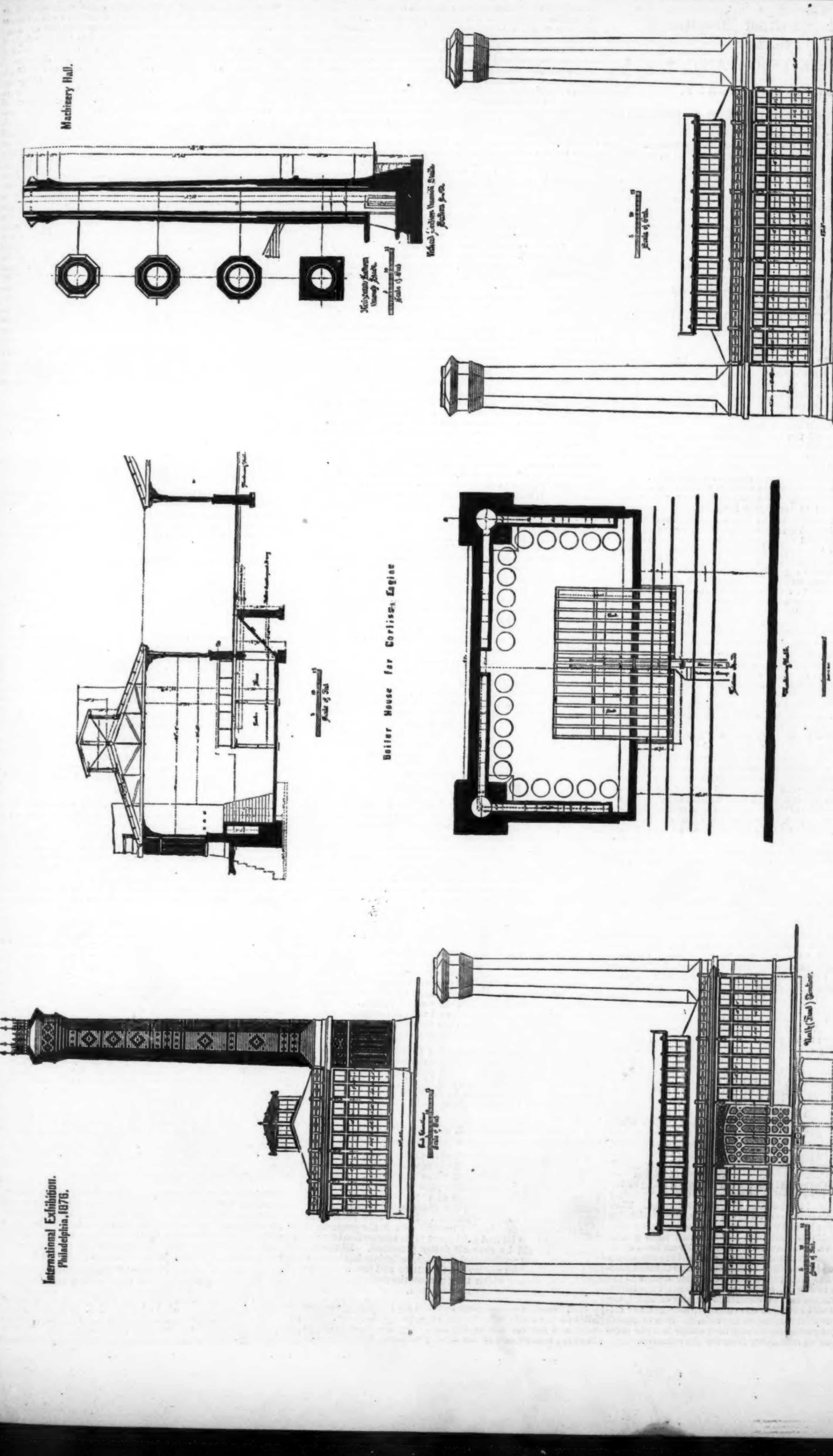
Instead of making holes in the sidewalk, the scaffold-poles are stood upright on the asphalt or flagging, and half a bushel or so of plaster mixed and piled around the bottom of each, and patted close with a trowel. In a few minutes the plaster sets, and the poles are firmly fixed.

The stone front, again, being laid up rough, and cut afterwards, it naturally happens that defects are found, or mistakes made. Indeed, where a man leans out of a window, and saws at the ashlar below with a cross-cut saw held at arm's length, it could hardly be otherwise. A little plaster, colored to imitate the stone, ekes out all these deficiencies; and some more plaster, with the stone-cutter's chips from the last building, makes up the whole of the rear walls. More plaster still, with the aid of some bricks, makes the partition walls in which the flues are carried up with short fire-clay pipes, square or oblong in section, with rounded corners, and built one on top of the other. These are about nine inches in diameter, and show on both sides of the wall, and the surface is ribbed so as to give some hold to the subsequent plastering. What would Mr. Inspector Shaw say to one and a half inches between the inside of the flue and the front of the wall?

What would he say, too, to such construction as is found in some of the rear walls?—in which I have seen a window, in a wall eighteen inches thick, formed by setting up two fragments of old scaffold-poles for the sides and another bit across the top. Of stone sill or lintel there was no trace; the wall—a concrete of chips and plaster rather than a wall—was shaped rudely around this primitive framework, and the surfaces smoothed over.

This was in a new building, with a beautiful front, and well-arranged plan—the kitchens of all the various apartments, by the way, being collected in the top story of the house.

The front was ornamented with the iron balconies which add so much to the beauty of Paris houses; but even these, elegant in design as they were, on close examination, seemed to have been cast in a long general pattern, and chopped off in lengths to suit the various windows; and the pieces were held to the posts by bits of stout wire. T. M. C.



THE INTERNATIONAL EXHIBITION OF 1876.—BOILER HOUSE FOR CORLISS ENGINE.—(*See page 214.*)

Scientific American Supplement.

No. 14.

FOR THE WEEK ENDING APRIL 1, 1876.

PUBLISHED WEEKLY,
AT THE
OFFICE OF THE SCIENTIFIC AMERICAN,
No. 37 Park Row, New-York.

MUNN & CO., Editors and Proprietors.

O. D. MUNN. A. E. BEACH.

The Scientific American Supplement is uniform in size with the *Scientific American*. Terms of subscription for Supplement, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

COMBINED RATES.

The *Scientific American* and Scientific American Supplement will be sent together for one year, postage free, to subscribers, on receipt of $7.00.

Remit by postal order. Address,

MUNN & CO., Publishers,
37 Park Row, New-York.

THE INTERNATIONAL EXHIBITION OF 1876.

STEAM GENERATORS, ETC., AT THE CENTENNIAL.

No. IV.

(See illustration on page 213.)

The collection of steam-boilers at the Exhibition promises to be of a much more extensive and varied character than has ever before been gotten together at any World's or other fair, and there will be on exhibition, in connection with them, a large number of devices appertaining to this branch of engineering, which possess novel and interesting features, beyond any thing that has yet been seen.

The construction of the various boiler-houses, and all the arrangements for the supply of water and fuel to and removal of refuse from them, show the work of a master-hand, and will certainly be regarded by our foreign visitors as advanced and thoroughly good specimens of engineering. One would expect, upon examination of these works, to find structures of a comparatively temporary character; much that would be desirable in structures for more permanent use sacrificed to a consideration of the necessarily short life of such an exhibition. These buildings, however, as well as all their adjuncts and dependencies, have the appearance, and indeed are of the most substantial character; and the Commission have spared no expense, nor the management trouble, to make them not only complete, reliable, and substantial, but at the same time ornamental and elegant in appearance. It seems to have been held strictly in view by the Commission, that nothing shall appear upon the exhibition grounds which shall present a flimsy, cheap, or in any way disagreeable appearance; at the same time nothing is done for a mere meretricious display of ornamentation, and none of the severely practical necessities of such structures as boiler-houses, derricks, artesian-well-boring apparatus, saw-mills, mining apparatus, etc., (of which there will be quite a number on exhibition outside of and detached from the main buildings), will be sacrificed to a consideration of mere ornament.

The boiler-house within which will be generated the steam to supply the large Corliss engines, of which I inclose you plans, will, I think, bear me out in all these respects. The figures show a front, back, and end elevation, a cross-section, plan view in section, and sectional views of the two chimneys. The level of the boiler-room floor is 10 feet below that of Machinery Hall, the foundation-walls below ground being of rough stone-work 20 inches thick. Above ground, to the height of 5 feet, is rough ashlar brown freestone work, upon which the light and elegant superstructure is erected; the whole of that part above the ground, except, of course, the chimneys, being uniform in design with Machinery Hall. For 42 feet in the centre of its length, the excavation and underground walls extend outside of the building toward Machinery Hall, and are overlaid with strong timbers which extend within the building 20 feet 4 inches, on a level with the floor of Machinery Hall, supported by appropriate columns, and, floored over, form a platform of about 850 square feet, from which visitors may view the operations of the fire-room, without obstructing or in any way interfering with the movements of the operatives. The outdoor ends of the timbers forming this platform are not floored, and the rails of a branch siding from the railroad-track which runs along the south side of Machinery Hall, are laid over them, so that the ordinary coal-cars can be run upon it, and discharge their contents directly downward upon an inclined plane, as shown in the cross-section, which conducts the coal into the bin beneath the platform. This bin will hold about two hundred tons of coal, and as it is to be presumed that the filling of it will be done out of exhibition hours whenever possible, visitors will always have unobstructed access to the boiler-room. With this arrangement, the coal used under the twenty boilers to be placed in this building will require no more handling after being placed in the cars than that given it by the firemen in supplying the furnaces, except, perhaps, in working a portion of it from that part of the bin farthest from the boilers, and then only when the supply may become comparatively short. In the plan view, the circles show the position of the twenty vertical, cylindrical tubular boilers.

The two chimneys are more than ordinarily fine specimens of this kind of work, and aside from the excellence of design considered simply from an engineering point of view, they can never be thought to be anything less than an ornament to Fairmount Park, if, as is probable, Machinery Hall and its immediate dependencies are kept for exhibition purposes after the Centennial shall have become a thing of the past; and with the exception of Memorial Hall, and possibly one or two others of the buildings have been removed. They are 100 feet high above the level of the grates. A more detailed description of the boilers will be given at another time; their distribution within the building, however, will be as shown, they being set in brick-work with the flues from each opening into the mains shown in the plan, and will require nearly 200,000 bricks to inclose them as designed. The Corliss boiler-house is known as No. 2. No. 1 is of similar design in the superstructure to Machinery Hall, as indeed are all the boiler-houses and annexes in the immediate vicinity of and lying south of it. It will have but one chimney, however, and differs in many essential particulars from No. 2. It is to furnish steam to all that part of Machinery Hall which is to be occupied by steam-using machinery from foreign countries.

West of the Hydraulic annexe and south of Machinery Hall are to be Annexes Nos. 1 and 2, adjoining each other, a portion of the area of No. 1 being occupied by boiler-house No. 3. Still further to the west and on a line with these annexes will be another, Annexe No. 3, containing boiler-house No. 4. There will be a separate house for the boiler which is to supply steam to the Shoe and Leather Building, another to perform the same function for a building, for which plans are nearly completed, to be erected near the railroad-track a considerable distance to the south and west of Machinery Hall, and to contain all the sawing machinery of any considerable dimensions; such as large circular and mulary saw-mills, gang-saws and edgers, and all such machines as are used in the preparation of lumber in the rough. Then there will be a boiler and house to furnish steam to the glass-works being erected by the Messrs. Gillinder & Sons, of Philadelphia, in the vicinity of the Saw-mill Building, one connected with and to furnish steam to the Agricultural Building, and some fifteen other comparatively small boilers, which form a part of self-contained machines, such as some of the varieties of hoisting, portable and semi-portable engines, upon which steam will be had during the Exhibition. These latter will be situated in one of the boiler-houses, and are not included in the large number of similar machines to be on exhibition (but not in operation) in the main building. If we add to the above the house covering the boilers and large pumping-engines which supply the Exhibition with water, we have in the way of buildings for the accommodation of steam-generators alone something enormous, while the power to be derived from the whole of these boilers of course presents equally formidable figures.

In boiler-house No. 1 will be placed three cylindrical boilers of Galloway's patent (English), each 7 feet in diameter and 28 feet long. In No. 3 will be a number of sectional boilers, among which are: the "Exeter" boiler of 100 H.P.; the "Dinsmore," 100 H.P.; the "Root's," 100 H.P.; a boiler by W. E. Kelly, of 50 H.P.; a "Babcock and Wilcox," 150 H.P.; a "Lowe and Watson," of 50 H.P.; a "Howard" boiler, 50 H.P., and the "Smith" boiler, of 100 H.P., aggregating 700 H.P. In No. 4 boiler-house will be a "Fermiervich" boiler, of 50 H.P., a very peculiar one, and which will excite a good deal of curiosity; the "Migand," 100 H.P.; "Harrison," 100 H.P.; "Lynde," 50 H.P.; "Andrews," of New-York, 50 H.P.; and some fifteen smaller hoisting and portable engine-boilers, mentioned above. The boiler of the Shoe and Leather Building will be of about 60 H. P., the Saw-Mill Building about 150 H. P., and to drive the machine-shop, situated in Annexe No. 1, will be a "Hoadley" engine and boiler of about 25 H. P. The rated H. P. of these boilers will amount, in the aggregate, to over 4000.

The Galloway boilers will be fed by two of Carr's steam pumps, having 6-inch water-cylinders, a smaller one from the same maker—4-inch—being used in the same fire-room, for the purpose of pumping the drainage from a cistern beneath the floor to the height and into the sewer. This is done in the fire-rooms of the four principal boiler-houses; the floors being below the level of the sewer system. The boilers in boiler-house No. 3 will be fed by two 6-inch "Blake" pumps, one—4-inch—being used for the drainage, and in No. 4 three of Knowles' pumps, of the same dimensions, are to be used. The Corliss boilers will probably be fed by a pump on the main engines, with the usual "donkey" for emergencies.

Attached to or connected with this great variety of boilers will be, if not all conceivable, at least nearly all that have proved to be practicable, kinds of safety-valves, feed-water, and damper regulators, low-water and high-pressure dams, gauge-cocks, water and steam gauges, manometers, thermometers, pyrometers, and the thousand and one improvements in all these which will go to make up a study for the inquiring engineer, which will be as curious as instructive, and such as will fall to his lot, like the great event this accumulation is to commemorate, but once in his lifetime.

J. T. H.

EXHIBITION NOTES.

Director General Goshorn has notified intending exhibitors that the space allotted them is ready, and that they must without delay make all necessary arrangements for foundations, connections, platforms, show-cases, railings, and so on. Another circular has been sent to all who have applied for space for special structures on the grounds, to the effect that all building material must be on the ground before April 1, at which date the transportation facilities hitherto granted will be withdrawn, the management requiring all their tracks, engines, trucks and cars for their own use.

The contract has been awarded for lighting Memorial Hall by means of electricity, and Machinery Hall and the Main Building by means of reflectors suspended from the ceiling.

No more passes will be given for admission to any of the Exhibition, the throng of visitors interfering with the work of final arrangement. After the opening, May 10, the price for admission will be fifty cents payable in one note. An exchange office will be established near each entrance to furnish the notes which will serve instead of tickets. In order that the cash boxes may correspond with the automatic registers at the turn-stiles, nothing but fifty cent notes will be received. No season tickets will be issued.

Owing to complaints of extortion on the part of Custom House brokers, the Centennial Commission has assumed the cost of the warehouse entry which places the goods within the Exhibition. Hereafter the entry of all goods for the Exhibition will be attended to by J. W. Hampton, Jr., Superintendent of the Customs Department of the Bureau of Transportation.

A Historical Department, with Mr. Frank M. Etting as chief, has been created by the Centennial authorities.

A portion of the Art Building has been set apart to illustrate the Colonial epoch. District compartments will be allotted to the Thirteen States, while the "Mother Country" will also assume her appropriate position. The walls will be devoted to historical paintings of events, and to portraits of individuals, while cases of plate glass will be provided for the reception of objects of interest. In order to perfect the plan it is indespensable that every epoch in the progress of each colony from its first settlement to its assumption of independence should be chronologically presented. Historical, antiquarian, and professional societies, collegiate institutions, and public libraries are invited to collate and transmit a list of the local events which they possess the materials to illustrate, and a catalogue of such materials.

One fourth of all the space reserved for the educational exhibit of the whole country has been assigned to Massachusetts, and the indications are that this will be insufficient. Drawing will be one of the most prominent features. The other school work, such as exercises, etc., will be bound in volumes, it being the aim to have one volume for each high school in the State, one volume to be made up from the work of the common schools in each town, and several volumes for the schools of the larger towns and the cities. There will also be an architectural representation of educational institutions, with illustrations of the buildings and grounds of all the colleges, professional and scientific schools, academies, seminaries, and prominent private schools; the best school-houses of the cities and large towns, and the best country school-house. Also views of all the public libraries.

The Centennial Light Association are trying to have each State represented by a memorial lamp-post in Fairmount Park. The design for California is elaborate and more of a monument than a lamp-post. The pedestal represents the trunk of one of the "big trees," with gold quartz piled about the base. A grapevine starting at the ground twines itself about the trunk, with fruit and leaves in relief. Near the top, branches are sawed square off, and on the face appears the coat of arms of the State cut in the wood. Above is an irregular-shaped plinth, which supports the figure of a miner, holding in his hand a cluster of star-lamps, the branches and pendants being decorated with fruits for which the State is famed. The pedestal is intended to be a symbolic representation of California as the Golden State, the great fruit state, etc. On this pedestal will be the seal of the state in high relief, and medallion portrait likenesses of distinguished citizens of California. The height of the pedestal with figure is thirteen feet, and with the cluster of lamps, seventeen feet. The whole is to be made of enduring bronze, and the money to be paid for it raised by individual subscription and volunteer entertainments.

The American Society of Engineers have undertaken to secure a proper representation of the progress made in engineering during the past century. Steam engineering will be illustrated by the Centennial Committee of the Franklin Institute.

The Philadelphia and Reading Railroad Co. will exhibit their styles of bridge-building in two models, the bowstring bridge and the Foreman truss. The latter will be 17 ft. 2 in. long, and 26 in. high.

The leading manufacturers of Germany have formed a committee for the purpose of sending artisans to Philadelphia, and the government has promised a large subvention.

Mexico sends to the Centennial a lump of silver, five feet nine inches in diameter, and worth $72,000, produced from 272 tons of ore. It contains but one tenth part of alloy, and comes from the Potosi Silver Mine. For safe keeping it remains in this city until the Exhibition authorities are ready to receive it.

There have been several changes made in the French Commission to the Centennial; it is now composed of the following gentlemen: President, Mons. A. L. de la Forest, consul-general, New-York; Ravin d'Elpeur, vice-consul, Philadelphia; Cat. Aunfrye, French legation, Washington; Mr. Imbert, vice-consul at New-York, secretary; A. Fredin, consular agent at Cincinnati, attaché.

The following is the official list of the members of the Turkish Commission just communicated to the Department of State at Washington: G. d'Aristarchi, envoy extraordinary and minister plenipotentiary; Baltazzi Effendi, first secretary of legation; Rustem Effendi, second secretary of legation; M. Edward Sherer, agent in the office of consul-general, New-York, and M. Auguste Grise, honorary member.

Mr. Eugene Felix, Austrian Commissioner, says that the representation of Austrian industries will be strongest in manufactured articles that display artistic taste, such as glassware, fancy leather goods, bronzes, meerschaums, amber, mother-of-pearl, and tortoise-shell ornaments, photograph-albums, etc. There will also be good displays of silk, cotton, and woollen fabrics, buttons, and musical instruments. Over 500 exhibitors will be represented.

The telegraphic facilities of the Exhibition promise to be ample and thorough. All the buildings will have abundant communication with each other, and with a central telegraphic building, in which the several telegraph companies will have their offices. The whole system will be under the direction of Mr. William J. Phillips, managing director of the American District Telegraph Company. Telegraphs from a distance will be delivered in all parts of the grounds free, and the rates for telegraphing will be the same as in the main office in Philadelphia, with no charge for local transmission.

For the protection of the Exhibition buildings and their precious contents against fire, a brigade of 200 experienced firemen has been organized, under the immediate command of Captain Joseph Hammond. The Director of the Centennial Fire Department is Atwood Smith, organizer and President of the Pennsylvania Insurance Patrol. Two fire-houses are to be built, and three fire-engines are to be detailed for constant duty. Five or six reserve engines, on exhibition in Machinery Hall, will have steam constantly attached, enabling them to go into actual service at any time, and a number of chemical fire-extinguishers are to be in readiness at points available and dangerous.

The sources of water supply are two. The Belmont Reservoir has a capacity of 40,000,000 gallons. The Schuylkill River, flowing close by, will render tribute through a powerful Worthington pump, which forces water to the summit of an ornamental stand-pipe, dominating the roofs of all the buildings. There will be water enough to keep the fountains in the grounds sparkling under sun and stars, and to drench the whole Exhibition in an hour, should that be necessary. In the Main Building there are seventy-four hose connections; in the Machinery Building, forty-seven. Around the exterior of the Main Building are thirty-six more water-plugs, and around the Machinery Building thirty-three. The rest of the buildings are protected in the same way.

The circular spot of ground on the west side of the terrace surrounding Memorial Hall has been selected as the site for a colossal granite statue of "The American Soldier," which is to be set up by the New-England Granite Company, of Hartford. The statue will be 21 feet high, and will weigh 30 tons. On the east side of the same terrace will be erected a marble statue of Washington, cut from a single block.

At the request of the Centennial Commission, the Fairmount Park Commission have set apart certain tracts of land between Belmont and Chamounl, on the west side of the park, and near the reservoir, on the east side, for the use of military encampments. The limits are not yet fixed, but it is estimated that the military reservations will cover two hundred and fifty acres.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY, LONDON, FEBRUARY 3, 1876.

PROFESSOR ABEL, F.R.S., President, in the chair.—Mr. W. Ackroyd read a communication on "*Metachromism, or Color Change.*" In this elaborate paper, the author, after giving a brief account of the notices scattered throughout various scientific papers on the subject of metachromism, as he terms the changes of color which various substances undergo when heated, passed on to the classification of metachromes, which he arranges in two groups—namely, those of the zinc oxide class, colorless bodies which acquire a yellow color on being heated; and those of the borate of copper class, which change from one color or combination of colors of the spectrum to the contiguous colors; the red iodide of mercury, for instance, becomes darker and darker as it is heated, up to about 140° C., when it is converted into the yellow modification. At higher temperatures the yellow becomes gradually darker, until at 220° C. it is a deep orange. From a study of the two classes, the following metachromatic scale was arrived at: White, colorless, violet, indigo, blue (metallic appearance), green, yellow, orange, red, brown, black.

The colors of the more refrangible end may be replaced by a metallic appearance. Metachromism has an important bearing on allotropy, a body expanding through the influence of heat being really a continuous series of allotropes. In support of this the relation of color and density was discussed. It was shown that metachromism is due to the storage of potential energy, the author holding that molecular vibrations or kinetic energy have nothing to do with this phenomenon of selective absorption. Contracting metachromes, changing from less to more refrangible colors, where would this change cease, providing a low enough temperature could be had? Presumably at the absolute zero of temperature, and at this point all metachromes would be white or metallic looking, judging from their behavior at attainable temperatures. Following expanding metachromes *from the absolute zero of color*, the change in each would vary with the coefficient of expansion, giving us at the normal temperature all that variety of hue which we see in the inorganic world. Including certain cases of decomposition (given in a table), color change may denote—

(1). If to more refrangible—α contraction, or
β decomposition.
(2). If to less refrangible—α expansion or
β combination.

The observations relate to anhydrous and for the most part binary compounds.

The paper concludes with some remarks on the simultaneous change of color and density observed on heating certain minerals, such as zircon.

The President said they were much indebted to Mr. Ackroyd for his interesting paper, which raised several points for discussion.

Mr. W. N. Hartley said for the past two years he had made many experiments on the changes which solutions of certain salts undergo when heated, but in most cases the change was due to a variation in the hydration of the salt, the series of colors, produced, however, being somewhat in the order given by the author. For instance, the brown or pink solution of cobalt when heated, darkens at first, the effect being probably due to expansion, but variation in the hydration then begins to come in, and the brown hexahydrate is reduced to the green dihydrate. Again the yellowish green color of a solution of copper chloride turns to brown when heated to 100° C., which may perhaps be due to metachromism. The solid copper bromide behaved in an entirely different manner; the golden yellow tetrahydrate loses water at a comparatively low temperature, changing to the brown monohydrate. The yellowish green solution of the salt changes to brown when heated like the chloride. In those solutions, however, in which no change of hydration takes place, the solution darkens, which is in accordance with Mr. Ackroyd's observations. A peculiar phenomenon is observed when dichroic minerals such as epidote are heated; the dichroism entirely disappearing under these circumstances.

Mr. Friswell understood the author to say that if the color changed to one at the more refrangible end of the spectrum, decomposition usually took place. He would like to ask whether he had examined any of the platino-cyanides: the red hydrated magnesium salt, as was well known, when heated, lost water, and changed first to orange, then to yellow, and finally to white, whilst the barium compound under similar circumstances also lost water, but changed from brilliant yellow to red-brown. Both these compounds undergo decomposition, and yet a change took place in opposite directions in the two cases.

Mr. John A. R. Newlands said that metachromism pure and simple included such changes as that of a white substance which when heated became yellow, and on cooling regained its original color. Other changes of a more permanent kind, as that of the scarlet mercuric iodide into the yellow modification of the same substance, having a distinct crystalline form, could hardly be included under metachromism, but might be rather considered as due to some chemical change. If the yellow mercuric iodide be regarded as the simple molecule, the scarlet modification might possibly be a combination of mercuric iodide with itself. At any rate it would be well to keep in view the possibility of the chemical combination of two or more molecules of the same substance, producing effects akin to those originating in metachromism.

Mr. Ackroyd replied, that in the case of mercuric iodide he had determined the specific gravity before and after the change, but the results were not concordant: the change from red to yellow would indicate contraction however. He had not examined the platino-cyanides.

Mr. Hartley said he might mention he had once observed that a magnificent specimen of the magnesium platino-cyanide, sealed up in a specimen glass which had been placed for a short time near a gas-flame, lost its beautiful green iridescence, and became of a yellowish color: after remaining some time in a cool place, it reabsorbed the water which had been expelled, and regained its original appearance.

Mr. W. H. Perkin, F.R.S., then read a paper "*On the Formation of Anthrapurpurin.*" Although it was known that potassium anthraquinon-monosulphate, when fused with caustic potash, yielded alizarin, it was generally believed that in the artificial preparation of alizarin the latter was produced from the disulphonic acid. This the author finds, however, is not the case: the alizarin is produced from the monosulphonic acid, whilst the disulphonic acid yields anthrapurpurin, a substance in many of its properties akin to alizarin. When the disulphonic acid is heated with potassic hydrate, it first yields oxyanthraquinon-monosulphonic acid $C_{14}H_6O_2(OH)(SO_3H)$, and this by the further action of the fused alkali, is changed to anthrapurpurin, $C_{14}H_5O_2(OH)_3$. The action of an aqueous solution of potash at a high temperature on this acid gives rise to an intermediate body, $C_{14}H_6O_2(OH)_2$, isomeric with alizarin, and apparently identical with the substance recently observed by Schunck and Roemer. It is converted into anthrapurpurin by the further action of the alkali. In alizarin the hydroxyls are both in the same benzene group, but in anthraquinon-disulphonic acid it would appear that one HSO_3 exists in each benzene group, which would account for the non-formation of alizarin from this acid when it is heated with an alkali, and would, moreover, tend to show that in anthrapurpurin two hydroxyls are in one benzene group and one in the other.

Dr. Armstrong remarked that there could be no doubt that anthraquinon had the formula—

$$C_6H_4\genfrac{<}{>}{0pt}{}{CO}{CO}C_6H_4$$

and since alizarin yielded phthalic acid on oxidation it was highly probable that the two OH groups were both in one benzene group, a view which was confirmed by the synthesis of alizarin from phthalic acid and pyrocatechin. The discovery of an isomeride of alizarin, to which the author had alluded, was of great interest: there were now five bodies known having the same composition as alizarin.

Mr. Perkin said that the isomeride alluded to did not yield phthalic acid on oxidation, from which it was probable that both the OH groups were not in the same benzene group. Anthraflavon, also, did not yield phthalic acid.

The President having thanked the author in the name of the society, a communication from Mr. C. O. Sullivan "*On Maltose*" was read, in which the author conclusively proves that maltose obtained by the action of malt extract on starch is not merely a mixture of dextrose and dextrin, but a distinct compound. Comparative experiments were made by treating both a mixture of dextrose and dextrin with alcohol and also maltose. In the former case the dextrose was removed, leaving a residue of dextrin which had scarcely any action on Fehling's test. With maltose, however, the case was different, the portion which dissolved having exactly the same reducing action as the undissolved portion. Fermentation experiments made with maltose and the above mixture led to analagous results. He concludes with observing that maltose is a distinct compound, isomeric with cane-sugar, and having a specific rotary power rather more than twice as great; moreover, 100 parts of maltose are capable of reducing as much cupric oxide as 65 parts of dextrose.

The President thanked the author, in the name of the Society, for his interesting communication; after which a paper, by Mr. T. Fletcher, was read, on "*A Simple Form of Gas Regulator,*" in which the author states he has had a regulator in use for the last fifteen years very similar to that recently described by Mr. Page, except that he passes the gas in the reverse way, and considers it is practically better to have a pinhole in the cork or centre-tube, to prevent the gas being extinguished, instead of the double service. He also recommends an iron chamber of large size, containing 2 or 3 lbs. of mercury.

The last paper by Mr. T. Carnelly, B.Sc., "*On High Melting-Points, with Special Reference to those of Metallic Salts,*" was taken as read, owing to the lateness of the hour. The principle upon which the experiments described in this paper were conducted consists in heating a small platinum crucible containing the salt by means of a Bunsen, or other suitable means, and the instant the salt is seen to melt the whole is dropped into cold water. From the observed rise of temperature the melting-point of the salt can be calculated. Tables are appended to the paper giving the fusing-points of a large number of substances as observed by this method.

ACADEMY OF NATURAL SCIENCES, PHILADELPHIA.

EVOLUTION

AT the last meeting of the Academy, according to announcement, Prof. Cope gave a history of the progress of the doctrine of evolution of animal and vegetable types. While Darwin has been its prominent advocate within the last few years, it was first presented to the scientific world in a rational form by Lamarck, of Paris, at the commencement of the present century. Owing to the adverse influence of Cuvier, the doctrine remained dormant for half a century, and Darwin resuscitated it, making important additions at the same time. Thus Lamarck found the variations of species to be primary evidence of evolution by descent. Darwin enunciated the law of "natural selection" as a result of the struggle for existence, in accordance with which "the fittest only survive." This law, now generally accepted, is Darwin's principal contribution to the doctrine. It, however, has a secondary position in relation to the origin of variation, which Lamarck saw, but did not account for, and which Darwin has to assume in order to have materials from which a "natural selection" can be made.

The relations exhibited by fully grown animals and plants, with transitional or embryonic stages of other animals and plants, had attracted the attention of anatomists at the time of Lamarck. Some naturalists deduced from this now universally observed phenomenon that the lower types of animals were merely repressed conditions of the higher, or, in other words, were embryonic stages become permanent. But the resemblance does not usually extend to the entire organism, and the parallels are so incomplete that this view of the matter was clearly defective, and did not constitute an explanation. Some embryologists, as Lareboullet and Agassiz, asserted that no argument for a doctrine of descent could be drawn from such facts.

The speaker, not adopting either view, made a full investigation into

THE LATER EMBRYONIC STAGES,

chiefly of the skeleton of the batrachia in 1865, and Prof. Hyatt, of Salem, Mass., at the same time, made similar studies in the development of the ammonites and nautili. The results, as bearing on the doctrine of evolution, were published in 1869 in a paper entitled "The Origin of Genera." (Proceedings of the Academy of Natural Sciences.) It was there pointed out that the most nearly related forms of animals do present a relation of repression and advance, or of permanent embryonic and adult type, leaving no doubt that the one descended from the other. This relation was termed *exact parallelism*. It was also shown that if the embryonic form were the parent, the advanced descendant was produced by an increased rate of growth, which phenomenon was called acceleration; but that if the embryonic type were the offspring, then its failure to attain to the condition of the parent is due to the supervention of a slower rate of growth. To this phenomenon the term retardation was applied. It was then shown that the inexact parallelism was the result of unequal acceleration or retardation; that is, acceleration affecting one organ or part more than another, thus disturbing the combination of characters, which is necessary for the state of *exact parallelism* between the perfect stage of one animal and the transitional stages of another. Moreover, acceleration implies constant addition to the parts of an animal, while retardation implies continual subtraction from its characters, or atrophy.

Prof. Haeckel, of Jena, has added the keystone to the doctrine of Evolution in his

GASTRÆA THEORY.

Prior to this generalization, it had been impossible to determine the true relation existing between the four types of embryonic growth, or to speak otherwise than to the effect that they are inherently distinct from each other. But Haeckel has happily determined the existence of identical stages of growth or segmentation in all the types of eggs, the last of which is the gastrula, and beyond which the identity ceases. Not that the four types of gastrula are without difference, but this difference may be accounted for on plain principles. In 1874, Haeckel, in his Anthropogenie, recognizes the importance of the irregularity of time of appearance of the different characters of animals during the period of growth, as affecting their permanent structure. While maintaining the view that the low forms represent the transitional stages of the higher, he proceeds to account for the want of exact correspondence exhibited by them at the present time by reference to this principle. He believes that the relation of parent and descendant has been concealed and changed by subsequent modification of the order of appearance of characters in growth. To the original, simple descent, he applies the term *palingenesis*; to the modified or later growth, *coenogenesis*. The causes of the change from palingenesis to coenogenesis, he regards as three, namely, acceleration, retardation, and heterotophy.

It is clear that the two types of growth distinguished by Prof. Haeckel are those which had been pointed out by the speaker in the Origin of Genera, as producing the relations of "exact" and "inexact parallelism," and that his explanation of the origin of the latter relation by acceleration or retardation is the same as that of the latter author. The importance which he attaches to the subject was a source of gratification to the speaker, as it was a similar impression that led to the publication of the Origin of Genera in 1869.

It remains to observe that the phenomena of exact parallelism or palingenesis are quite as necessarily accounted for on the principle of acceleration or retardation as are those of inexact parallelism or coenogenesis. Were all parts of the organism accelerated or retarded at a like rate, the relation of exact parallelism would never be disturbed, while the inexactitude of the parallelism will depend on the number of variations in the rate of growth of different organs of the individual, with additions, introduced from time to time. Hence it may be laid down that synchronous acceleration or retardation produces exact parallelism, and heterochronous acceleration or retardation produces inexact parallelism.

In conclusion, it may be added that acceleration of the segmentation of the protoplasma, or animal portion of the primordial egg, or retardation of segmentation of the dentoplasma, or vegetable half of the egg, or both, or the same relation between the growth of the circumference and centre of the egg, has given rise to the four types which the segmentation now presents.

ROYAL GEOGRAPHICAL SOCIETY, FEBRUARY 14.

THE journal kept by Mr. Margary in his great journey across China to Burma was the subject of discussion. Mr. Margary received instructions in 1874 from Her Majesty's minister at Peking to proceed through the vast southwestern provinces of China across the frontier of Yunnan and to Burma, there to await the expedition under command of Colonel Horace Browne from Calcutta, which had received passports to examine the great routes of possible trade between Burma and China. Mr. Margary successfully accomplished this great task, voyaging up the Yangtze and its tributary the Yuen, and afterwards travelling by land through Yun-nan and Tali-fu, he reached Bamó on the upper Irrawadi on January 15, 1875. With the exception, perhaps, of one of the old Jesuit geographers, Margary was probably the first European who had ever performed this great feat of 2000 miles of travel.

His journal, though full of interest, does not add very much to geography, since the greater part of the country had already been mapped in the Jesuit surveys. The descriptions of wide unoccupied grass-lands in Western China are striking when compared with the accounts of the minutely cultivated and densely peopled plains of the East. Mr. Margary gives interesting information respecting the Miau-tse, or aboriginal inhabitants of the hill country of Southern China, who during the Han dynasty, or from perhaps 200 B.C. to 200 A.D., were the masters of the whole of south-western China, and had their capital at Tali-fu, and who are of the same race as the present Shans of Burma and Siam.

After but a few days' rest at Bamó, Margary started on the return journey with Colonel Browne's expedition, the intention of the leader being to cross into China by the southern or lower mountain passes from Sawuddy, but meeting with various hindrances and strong opposition on the part of the natives, this line was abandoned, and the northern dangerous and difficult track was determined on. Going on in advance of the expedition to reconnoitre when near the town of Manwyne, in the neutral territory of the borders of Burma and China, a no-man's-land in which outcasts and malcontents of both nations gather, Margary was attacked and killed.

In discussing the journal, Sir Rutherford Alcock pointed out the evidence it gives of the power of the Chinese Government in the remote provinces, the Peking passport having been respected at the furthest limits of the empire; he discouraged, however, the idea of immediate opening of trade with interior China, believing that the time had not yet come when it could be advantageously carried on. Colonel Yule described the relations of Margary's journey to that of Marco Polo, and to Lieutenant Garnier's discoveries from the Mekong River to Tali-fu in 1866.

NEW COLOR.

A PATENT has been taken in France, in the name of MM. Carré, for a color composed of extract of logwood, chromic acid, and aniline blue-black, known in France as *bleu-noir coupier*. These substances are mixed in various proportions, according to the use to be made of them. Equal quantities of the logwood extract and of the blue-black, with a minute quantity of bichromate of potash, form a color which, laid on thinly, becomes indelible after a short exposure to the air. The same effects may be produced in dyeing by throwing the above-named substances one upon the other by the ordinary means. A final washing in an acidified or alkaline bath will, of course, give a blue or a violet tint.

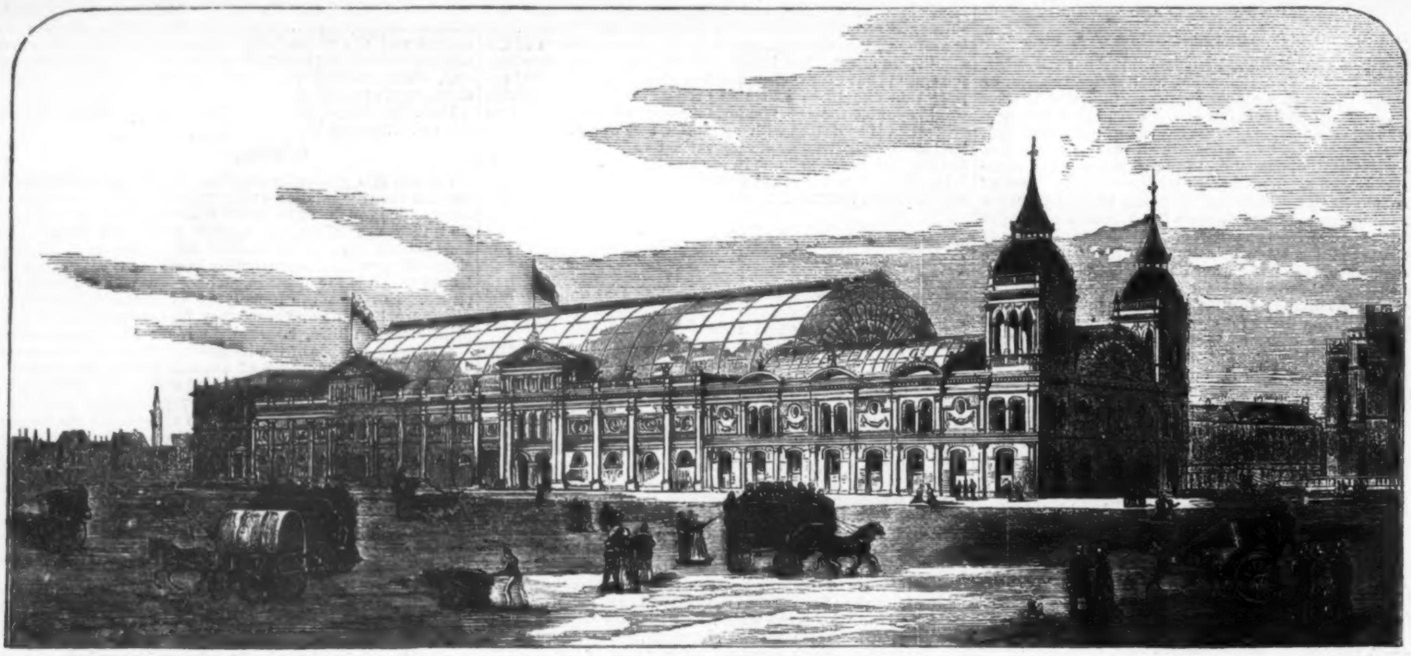


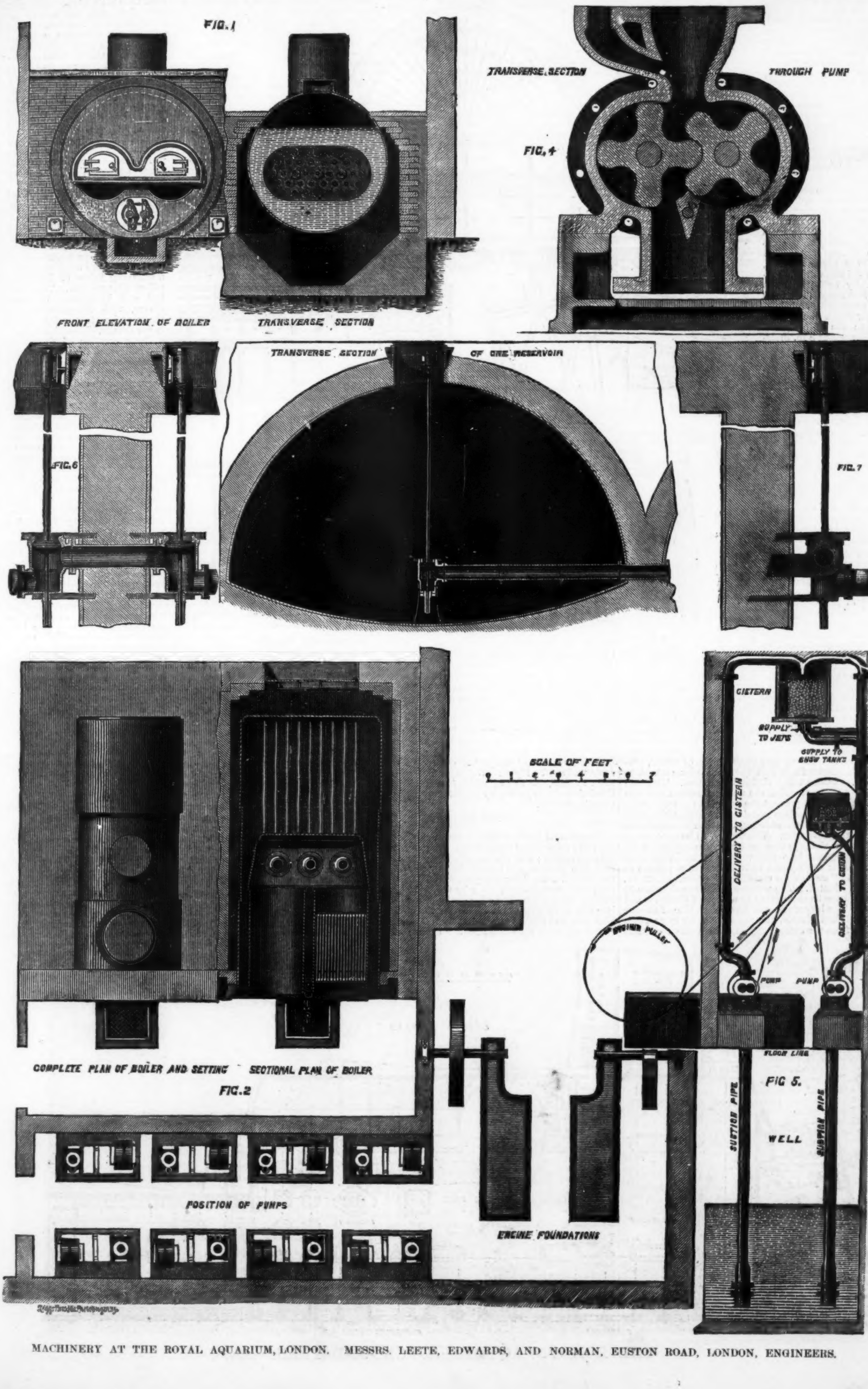
FIG. 1.—THE ROYAL AQUARIUM, LONDON.

THE ROYAL AQUARIUM, WESTMINSTER.

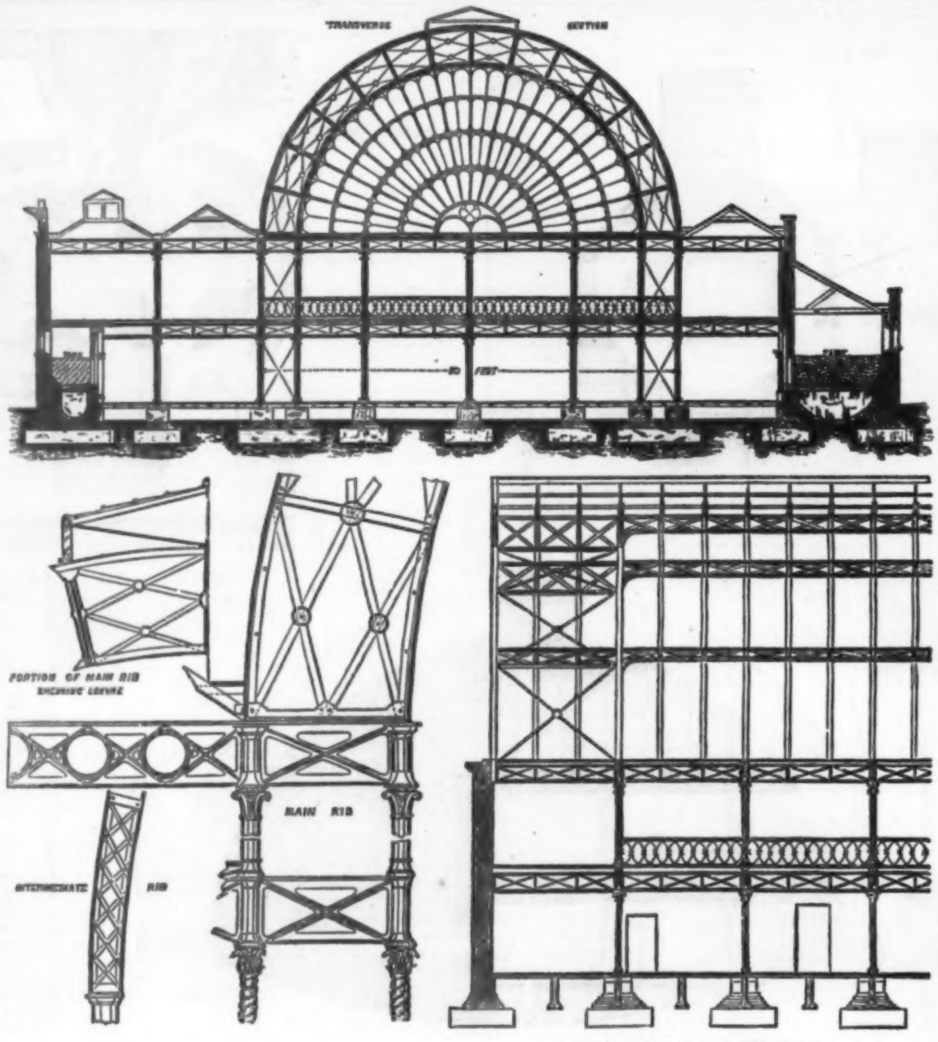
The Royal Aquarium at Westminster, just finished, represents a class of public buildings quite unknown a few years ago. Aquaria, winter gardens, floral halls, and skating rinks appear to be the popular resorts of the day, and have opened a new field for speculative companies and a novel source of work to the architect. The present structure, occupying a central and conspicuous position under the very shadow of the venerable Abbey of St. Peter, and covering nearly three acres of ground in a neighborhood which not many years since was a dense mass of human habitations of the worst kind, was begun and has been completed in the unprecedentedly short space of time of scarcely a twelvemonth. It was commenced in March, 1875, and opened 22d January, 1876. The building is situated in Tothill street, its end facing the Broad Sanctuary—thus forming another addition to the architectural achievements of this part of the metropolis. In the Great and Little Sanctuaries many old taverns existed, some of bad repute; the Almonry where the alms of the Abbey were daily doled out stood here, and the locality is more memorable as being the site on which the Caxton printing-press was first set up in England. Stow, and Mr. Mackenzie Walcott, in his "Westminster," describe the purlieus of Tothill street, along which now extends the long façade of the new Aquarium. The houses in Tothill street and the Little Sanctuary were remarkable for their overhanging fronts and timbered gables. Now palatial buildings have taken their place—the Westminster Improvement Act has swept away dens of poverty and crime, and we see stately rows of houses devoted to business and a great pile of red brick, glass, and iron, destined shortly to be thronged with the votaries of pleasure and intellectual entertainment. The length of the building is about 600 ft.; it comprises a summer and winter garden, a theatre or concert-room, a reading-room, and will also shortly include a skating rink to add to its other attractions. The scheme, as we now see it, was originated by Mr. Wybrow Robertson, who thought that a garden and conservatory in the heart of London, for the display and cultivation of some of the richest productions of animate nature and works of fine art, would be a great boon. A company was formed with a capital of £200,000, in shares of £5 each, and the site was secured at a cost of £80,000. Messrs. Lucas Bros., who built the Alexandra Palace, of which this may be called a development on a smaller scale, undertook the contract for the erection for the sum of £88,000, making a total outlay of £168,000. The wife of the architect, Mr. Alfred Bedborough, of Abingdon street, laid the first stone of the new structure on the 18th of March last year. The materials are red bricks from Fareham used as facings, and the stock bricks were supplied by Mr. W. T. Wiseman, of the Hop Exchange, Borough, who is also supplying the Yarmouth Aquarium and the new National Opera House, Portland and Bath stone dressings, the roof and internal structure being of iron and glass.

The plan consists, as will be seen on reference to our illustrations, of which we give three pages, of a promenade or conservatory with surrounding aisles, forming the main portion of the structure. This is a parallelogram in form, about 340 ft. by 160 ft. in the clear of the walls, with an eastern portion or entrance hall, 136 ft. by 80 ft., facing the Broad Sanctuary, the elevation of which we illustrate in detail. At the west end, forming a distinct building, and separately treated externally, though connected with the main structure, is a concert-hall 106 ft. long by 62 ft. wide, with lobby entrance, orchestra, or stage, 60 ft. wide, refreshment and waiting-rooms, and attached offices. At the north-west corner is a square reading-room, a commodious apartment, about 48 ft. square, with rooms for band and choir, and dressing-rooms in communication with the orchestra. At the same corner are provided lavatory and cloak-rooms, and reserve tanks. These parts of the plan ingeniously make up the irregular boundary of the site. Opening on the north side of the promenade, centrally placed, in a semi-circular recess formed within the depth of the gallery and aisle, is the orchestra, with adjoining conveniences. Its diameter is about 60 ft. A passage on the outside gives communication with the back entrance. The building has galleries all round of 20 ft. bays, projecting from the side walls about 40 ft. The main ribs are in pairs, 20 ft. apart, and spring from coupled columns placed transversely. They are semi-circular in shape, the span is 68 ft., and the depth of rib 6 ft. (See details.) Between these pairs the bays are 40 ft. wide, except at the ends and in the middle; in the last the span is about 30 ft. The columns which carry the main ribs are placed 6 ft. apart from centre to centre, and project this distance from the gallery front. They are tied together at the gallery and aisle levels, above which the main circular lattice ribs of roof spring. The outer members of the

FIG. 2.—INTERIOR OF THE ROYAL AQUARIUM, LONDON.



MACHINERY AT THE ROYAL AQUARIUM, LONDON. MESSRS. LEETE, EDWARDS, AND NORMAN, EUSTON ROAD, LONDON, ENGINEERS.



THE ROYAL AQUARIUM, LONDON.—ELEVATIONS.

rib are composed of two angle-irons 4 in. by 3½ in. by $\frac{7}{16}$ in., riveted to outer plates 9 in. by $\frac{7}{16}$ in.; these are connected by open lattice bars 3½ in. by ⅜ in. and by radiating channel irons about 8 ft. apart. Intermediate ribs of lattice design, about 1 ft. 4 in. deep, spring from the intervening pillars. Between the main ribs, 20 ft. apart, cross-braced purlins are carried 5 ft. in depth, and purlins of about half that depth support the other bays of roof. The purlins are chiefly of bar and angle-iron, and they are kept at right-angle positions with the ribs by angle-pieces or brackets. The horizontal girders which connect the columns are of the Crystal Palace design, except that circles are introduced in the lozenge-shape panels of the cross bars. For the gallery these cross girders are trussed by tension rods below the upper member, and the rib columns are tied together laterally by 1¼ in. cross rods, to prevent sway. There are two tiers of columns—one below, and the other above the gallery level. These are of octagonal form in section, about 8 in. diameter, and have cast floriated caps and moulded bases. It may be mentioned here, to show the extreme care in the preparation of the drawings, and the skill exercised by Mr. Clements, the general superintendent, that not a hole had to be drilled in fitting the ironwork. The section shows the construction of the aisles, which are in double bays, the outer one embracing the show tanks. The ironwork was supplied by the Thames Ironwork Company, Blackwall, and the design and execution of this part of the work as a whole, composing as it does the greater portion of the structure, are very satisfactory. The general height and dimensions of these portions are as follows: The height of gallery from the floor of promenade is 16 ft., and the upper story to the springing of the circular roof is also 16 ft.; the total height of nave, from floor to crown of roof, is about 72 ft. The galleries are devoted to refreshments and to fine-art purposes.

The main avenue is 80 ft. wide, being 8 ft. wider than that of the Crystal Palace. For the supply of salt water nine long tanks are constructed under the promenade floor, and occupy a rectangular area of about 260 ft. long by 53 ft. They are placed lengthwise, 3 in length and 3 in width. In section they are semi-cylindrical vaults, shown in our small section, with segmental inverts resting on a bed of concrete, and are faced with concrete. The arches are in three rings. These reservoirs or tanks are capable of holding over 800,000 gals. of water, one-fourth of which will be fresh and the remainder salt. The asphalting of the arches was a difficult operation. The iron pipes and valves through which the water circulates are also coated with vulcanite, to prevent the action of the iron on the salt water. Wells, 15 ft. deep and 8 ft. square, at the west end communicate with the reservoirs, one with the fresh and the other with the salt water. The water will be pumped up from the reservoirs through these wells by two engines of 20-horse power (nominal) into the various tanks. The same water will serve for many years, as it undergoes a process of oxygenising, the "continuous circulating" system of Mr. W. A. Lloyd being adopted. The water will have to circulate 3¼ miles, and will thus be maintained in a state of clearness and heathfulness. The larger show tanks on each side of avenue have sills of polished granite, and are lighted by large semi-circular lights from the outside and also from the top. The fronts are of 1 in. plate glass, having cast-iron mullions with slate fillets behind the rebates as security against leakage. The fronts are inclosed by elliptical arches, the tympana or spandrels of which are formed of painted tiles of characteristic design, by Messrs. Doulton, of Lambeth; while the admirable panel tiles in the piers are by Gibbs and Moore, examples of which we shall publish next week. Prismatic lights in circular openings occupy the centres of the arched spandrels, and are by Hyatt. We must not omit to say that the main avenue, the roof of which is semi-circular, is glazed on Rendle's patent system, by which no putty is used, and bent glass is avoided.

THE INTERIOR.

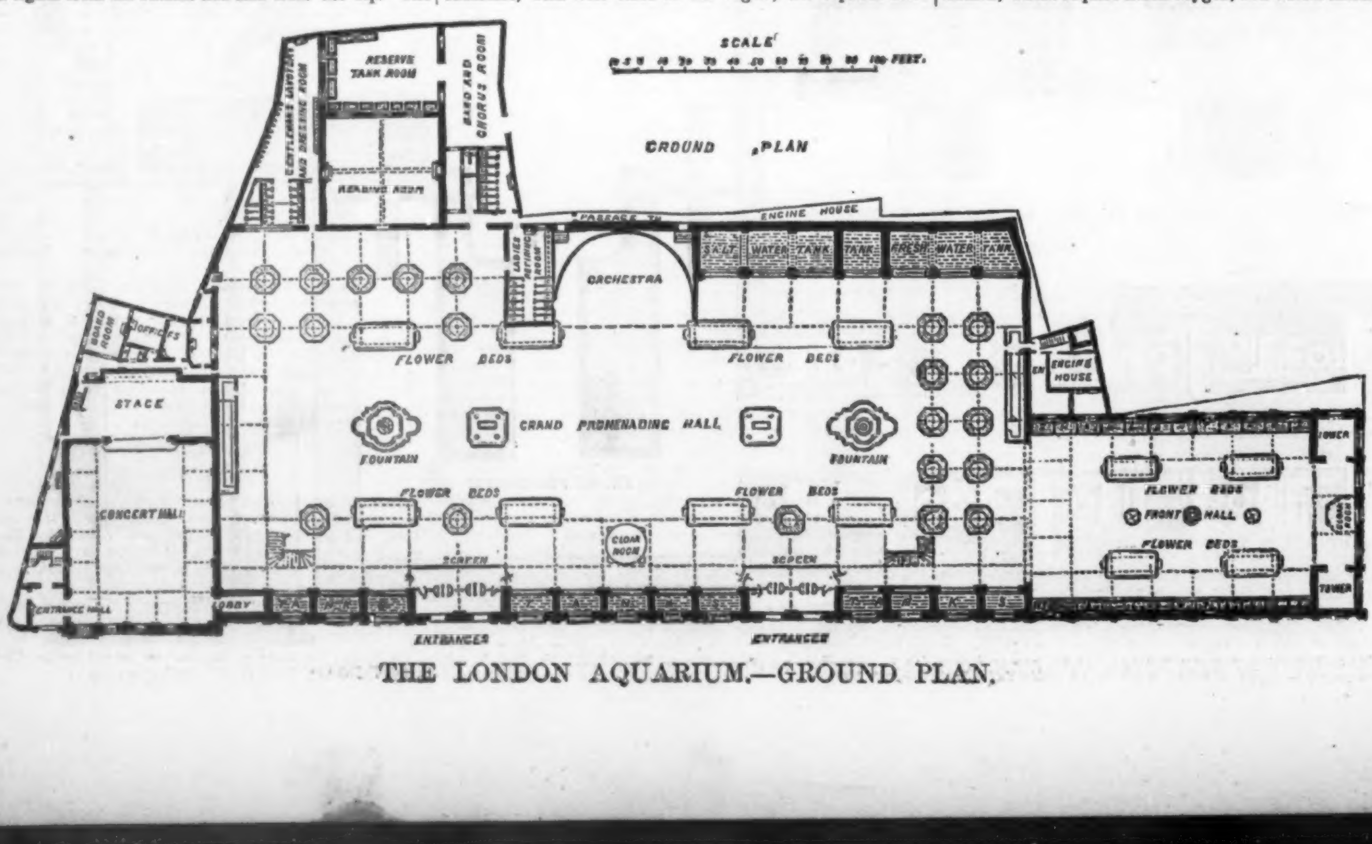
The general interior effect is satisfactory. There is a light yet rigid appearance in the large avenue roof, with its deep coupled arches; and the monotony generally inseparable from long iron structures is here broken by the projecting bays alternating in the long perspective. The decoration departs from the principles laid down by Owen Jones in the Crystal Palace. The prevailing color of the ironwork is here chocolate red, with gray or blue lines on the prominent portions. The ribs and girders are similarly treated. The pillars are chocolate, with blue lines in the edges; the capitals have dark blue bells, picked with gilt and color; and the gallery balustrading has the floral parts picked out in colors, and the panel lines gilded. In the entrance hall the prevailing color is mauve, with red lines and bright colors in the decorative parts. The gallery floor ceilings are blue or gray, the trussed girders being chocolate. The upper ceilings are of plaster, with deep splayed panelled sides, and skylights in centre. The ceiling of theatre is to be of carton-pierre, and is of a chaste Renaissance character, with a deep cove.

Exteriorly the Tothill street façade is crowned by triangular pediments over the two entrances, and the front or entrance by segmental pediments, alternating with the straight cornice. Emblematic representations of Neptune and the sea-horses, with a crowning figure of Britannia, relieve this portion. The main hall end is flanked by open towers, with Aberdeen granite shafts and slate cupolas, shown in our details.

The decoration of the north-east gallery, in the shape of wall painting and floral designs, is by Mr. Waigner; while the gas-fittings, from the designs of the architect, are characteristic adaptations, birds and aquatic plants making up their composition. This part of the work has been entrusted to Messrs. Forrest and Sons. The slate tanks are by Mr. Stirling, of Belvedere street; there will be 9 fresh-water and 22 sea-water show tanks, and some reserved as a hospital for sick animals. These tanks are supplied by the machinery before described, made by Leete, Edwards, and Norman. The hot-water apparatus is by Mr. Phippson, engineer. The design and superintendence of the various portions of this structure have been under the personal control of the architect, Mr. Bedborough; the immediate supervision and management was entrusted to Mr. Charles Greenman; Mr Robertson was the foreman. Among the attractions proposed by the directors may be enumerated annual fine-art exhibitions, under the direction of an art committee of the highest standing. Gold and silver medals, and other prizes have been offered. Mr. George Cruikshank's works have been purchased by the society, and a photographic portrait studio is in course of construction by the London Stereoscopic Company. Music will form a great feature, and the direction of this department has been entrusted to Mr. Arthur Sullivan. We are indebted to the *Building News* for the foregoing particulars, and to *The Engineer* for our engravings and the following:

TANKAGE OF THE AQUARIUM.

Although in the ocean the presence or absence of animal life depends on considerations of food in certain places, and upon soil or the nature of the sea's bottom, upon temperature, etc., yet the chief thing which affects the nature of marine fauna is motion, and this is because motion, by constantly exposing fresh water surfaces for the absorption of air, is the means of administering to animals the necessary amount of oxygen in the water, without which they can not live, as water alone will not support them. Most persons are conversant with the fact that a comparatively stagnant pond has its own character of inhabitants, as carp or tench, which do not need much oxygen, and that they are very different from trout and salmon, which require much oxygen, and which therefore ob-

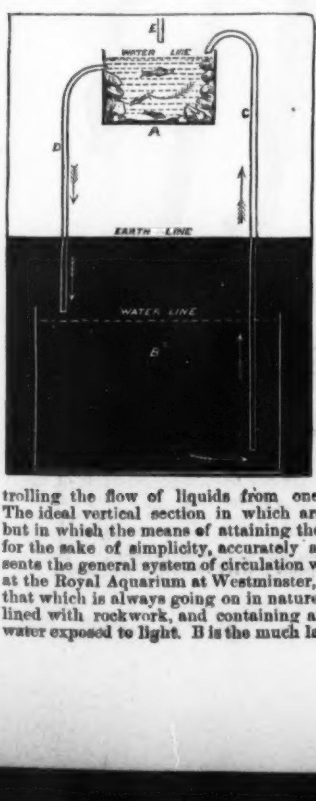


THE LONDON AQUARIUM.—GROUND PLAN.

tain it in rivers and brooks which are rich in oxygen because swiftly-running, and the reason why such speed of motion is attended by the acquisition of oxygen is because the motion presents constantly new surfaces for the absorption of that gas, the water being all the same, and that which to-day may be the water of an almost stagnant pool may to-morrow form part of a rushing river, without any change of its elementary constituents of oxygen and hydrogen combined. It is just the same in the sea, where an abundance of oxygen is needed not only for living animals, that their blood, or other respiratory fluids, be kept sufficiently pure, but also that the dead organic matters, both animal and vegetable, which are ever forming, may be not suffered to accumulate, but by combination with oxygen may be constantly resolved into their primary and harmless constituents.

When water is exposed to daylight at moderate and ordinary temperature, vegetation is sure to appear on most substances immersed in it. The use of this is because water so exposed also becomes attended with the presence of animal life, and it is not possible for animals to exist without vegetation to decompose the carbonic acid gas evolved by their respiration, and which, if not removed by counteraction, would poison them. This vegetation, therefore, fixes the carbon of the carbonic acid gas and sets free the oxygen, and thus the water is assisted to be kept pure in a manner which contact with atmospheric air alone would not do, great as is the affinity of the water for the air, and which air is in its turn always maintained pure by coming in contact with terrestrial vegetation. In this manner a never-ending and reciprocating cycle of life is maintained everywhere.

It is the oxygen, and not the nitrogen, which is the great source of purification of whatever in the water needs to be purified or got rid of by being combined with this oxygen. If the work of purification is required to go on faster than it would proceed if the water remained comparatively quiescent, we have only to agitate the water more, so as to bring new surfaces more speedily in contact with the oxygen. This may be done by splashing or agitating the water, as with a stick, etc., or by pouring it from one vessel into another through a more or less great interval of air, which it will absorb in passing; or, more neatly, by drawing up a portion in a syringe, and then, holding the point of the syringe at about one inch above the water's surface, to drive the water back again with force, when the entering current will entangle and carry down with it into the water a very large quantity of minute air-bubbles, much greater indeed in number and more desirably small in size compared with the little quantity of water injected, than can be commanded by any other known mode. This mode is particularly adverted to now, because its application will presently be shown. In course of a short time, therefore, which will vary in duration according to temperature and some other influences, the once turbid and ill-smelling water will have become clear and free from taste and smell, and if it has been exposed to moderate daylight, vegetation will have made its appearance, without having been visibly introduced, and from this vegetation, consisting of a slight downy green or purple film in some cases, or a filamentous growth of either color in some others, bright bubbles of pure oxygen gas will arise under the influence of daylight, which means, of course, diffused or subdued sunlight. The effect of this vegetation is that the water has become not merely clear, but sparkling, and that the same kind of animals which formerly died in the same water will live perfectly well and permanently in it so long as the amount of animal life introduced, while exercising all its functions and wants, be not in excess of the amount of oxygen from the atmosphere and plants which the water can absorb and retain. But there is very apt to arise another kind of excessive vegetable growth which no animals can restrain—that is to say, nature is so persistent in caring for the well-being of animals by the introduction of plant-life, that whenever a limited quantity of water, and especially sea-water, is confined in a vessel to which light has free and uninterrupted access, the number of the locomotive seeds or "zoospores" of the lower kinds of plants increase in number so enormously by a process of compound self-multiplication, that, from their presence in innumerable multitudes, the whole mass of water becomes densely colored of an opaque greenish-brown hue, hindering any thing being seen within it, though not necessarily being adverse to the health of any animals it may contain. The cure for this serious evil has been found to be the reversal of the causes which induced it—namely, to darken the water. But, as if the whole of it were darkened, both animal and vegetable life would cease to exist, the plan adopted is that which permits a portion of it to be made dark in another vessel in constant communication with the one in the light, and which is to be kept clear. In a small way, or for a temporary purpose, the light vessel may have its water supplied from the dark one by dipping out the water when necessary from the latter, which contains neither plants nor animals, and which is in a state of great purity. This process is attended with two other advantages, however—it permits the whole mass of fluid to be much increased for the advantage of the animals, and it is attended by the very beneficial motion, and consequent oxygenation, which accompanies the interchange of water; therefore the larger the dark vessel is in relation to the light, the better will be the condition of the whole arrangement. On a large scale of course such interchange by dipping would be impracticable, and recourse must be had to a system of machinery of pumps worked by hand or other power, and to pipes and the usual other modes of effecting and controlling the flow of liquids from one vessel to another.



The ideal vertical section in which are shown results only, but in which the means of attaining the results are omitted for the sake of simplicity, accurately and completely represents the general system of circulation which is being adopted at the Royal Aquarium at Westminster, and which, indeed, is that which is always going on in nature. A is the show tank, lined with rockwork, and containing animals and plants in water exposed to light. B is the much larger reservoir or tank containing water in darkness, with no animals. C is the pipe conducting water from B to A, and D is the pipe conveying water overflowing from A to B. The six arrows indicate the direction of the flow. E is the pipe supplying the small quantity needed to compensate for evaporation, and which, both with the fresh and sea-water departments at Westminster, will be distilled water. If all this be clearly understood, a reference to the various illustrations now published will be easy.

Referring to the ground plan of the Aquarium, and below the part of it marked "grand promenade hall," is the dark tank or reservoir, holding about 700,000 gallons, of which about three fourths are sea-water and one fourth fresh water; for it is also not intended to change the latter, as it can be kept in much better condition than any which can be supplied by water-works, while the money cost of using water only once and letting it run away to waste would be enormous and continuous. But, as the value of the total quantity of prepared sea and fresh water will be over £4000, it is necessary to guard against its loss from leakage; and therefore it is divided into nine easily isolated parts. In transverse section the reservoir is like three asphalted tunnels, each arched below and above and placed side by side, and each of the three are by cross walls divided again into three. A transverse section of one division is here given, showing a pipe running along the bottom and about 18 in. above it, supported at 5 ft. intervals by piers. At the parts of the cross walls where these pipes pass through them, the pipes are interrupted by some very ingeniously contrived double-seated valves, eighteen in number, arranged by Mr. C. H. Norman, of the firm of Leete, Edwards & Norman. If any division is found to leak, the valve can be by its long spindle screwed up to the upper seat, and then the water, instead of flowing into and through that particular division, will pass through the horizontal pipe at its base into the next division, and the other division, thus isolated, can be emptied and examined without loss of water or interruption of the circulation.

It has been explained how the sun, as a prime motor in nature, moves the waters of the ocean, but as this can not be made available in an aquarium, heat is made use of in another form, namely, in the furnace of a steam-engine boiler. These boilers, of 20-horse-power each, are made much larger than are required to drive the two 8-horse-power engines, because a large quantity of "live" steam will be needed to heat the water by which the entire building will be warmed on Phipson's plan. The rotary pumps—Forbes and Edwards' patent—are the best known for aquaria, as they permit the use of vulcanite, because metal would corrode by the action of sea-water, and would spoil it and poison the animals. Their simple action—that of rolling and not rubbing—makes them very lasting, and they are adopted in aquaria at the Crystal Palace, Southport, Rothesay, Naples, Vienna, and other places.

The eastern ends of the reservoir are, by two large vulcanite pipes contained in a culvert, connected to the two pumping wells, one for sea water and one for fresh water, which wells, with the pumps and suction and delivery pipes, and one of the two cisterns above into which the water first goes, are all shown in section in Fig. 5. Fig. 6 shows the mode of connection between two reservoirs, and Fig. 7 shows the return pipe at the end of one reservoir.

The course of the circulation is therefore as follows: The water in the reservoirs being of course at the same level as in the pumping wells, it is pumped—the sea water and the fresh water—simultaneously but separately into the two cisterns, the top levels of which are 7 ft. higher than the water level of the highest show tanks, and 11 ft. higher than those of the lowest of them. The circuit commences with the large sea-water tank at the northwest corner of the series, and it from thence enters the next tank eastward. At that point it by a pipe dips below the floor, and goes southward across the building and recommences its course at the easternmost of the twelve large tanks occupying the southwestern frontage of the building, a portion of it, however, being diverted to supply the row of eight smaller tanks—wrongly shown as twelve tanks—on the south side of the eastern or narrow portion of the building. The sea water continuing its course from east to west along the twelve tanks just named, again at the southwest corner dips below the floor, and travels across the building northwards to supply the private reserve tanks in a room at the northwest corner of the building. When it has done its work there it again goes below the floor, and travelling once more southwards enters the reservoir at its southwest corner, and then in seven of the nine reservoirs it travels backwards and forwards in a horizontally serpentine direction till it reaches the northeast corner, where it enters the pumping-well, and commences a new circuit. The fresh-water circulation is exactly the same, but shorter and simpler. The water is pumped from its well into its cistern, from whence it enters the large tank at the northeast corner of the series, from whence it enters one of its two reservoirs at the southeast corner, and travelling west, it enters the second reservoir, and going eastwards from thence, enters its pumping-well. A part of the fresh water is taken from the cistern to supply the series of eight small tanks at the northern side of the narrow or eastern part of the building. In both the sea and fresh water departments about one tenth of the entire quantity of water circulated is separately conveyed by a smaller pipe to each of the show tanks, which it enters with force through small jets, and sends down into the water every instant innumerable multitudes of very small air-bubbles, which by the enormous aggregate surfaces of air they thus expose to the water, aerate the latter most effectually, just in the same way as would the syringe already referred to. To represent the under currents of the sea, an arrangement is made by which the water in the show tanks travels in a vertically serpentine course downwards and upwards. The entire distance over which both kinds of water travels is about three miles.

The boilers and engines are in duplicate, so as to avoid stoppage of the current in case of accident or repairs. But there are eight pumps—four each for sea and fresh water, not only to attain still greater safety, but for economy in many directions. The quantity of water circulated will be from 15,000 to 30,000 gallons hourly, day and night, the amount varying according to the temperature of the atmosphere, the number of the animals, and other circumstances.

The entire circulating system, as here described, which is the essence of the success of the whole establishment, is the invention of Mr. W. A. Lloyd, the naturalist of the Westminster and Crystal Palace, and many other public aquaria, and the separate dark reservoir was suggested to him twenty years ago by the separate condenser, as applied by James Watt to steam-engines.

R. WAGNER states that resorcine, if mixed with sulphate of copper and so much ammonia as to redissolve the precipitate which appears at first, yields a deep black liquid, which dyes wool and silk black, and may probably be used as ink.—*Reimann.*

NATURAL HISTORY.

THE INDIAN RAINBOW-FISH.

M. P. CARBONNIER has had an opportunity of watching the breeding operations of the Indian rainbow-fish (Colisa), and has communicated a most interesting account thereof to the French Scientific Association. The fish were received by him living, in 1873, and are described as being of extraordinary beauty of color and form. But the most remarkable peculiarity which they present is the wonderful ingenuity exhibited by the male in building a nest for the protection of the eggs. As the time for laying approaches he takes in his mouth bits of confervæ, which he brings to the surface of the water and dexterously supports there by a little float, consisting of a bubble of air inserted beneath each mass. He accumulates these air-bubbles towards the centre of the vegetable mass, which, as it increases in bulk, is raised into a sort of mound to the height of more than an inch and a half. From time to time he leaves his work to swim around the female in sinuous curves, displaying his gorgeous variety of color, and doubtless seeking her applause for his labors. The nest is completed by a narrow rim of vegetable matter placed around the central mound, so that the whole is quite like in form to a straw hat with a round crown. He persuades the female to enter beneath this nest to lay her eggs, which, being lighter than water, rise to the surface, and are collected by the father beneath the central dome of his nest. The mother takes no further interest in the affair, but goes off about her business, leaving the patient nest-builder to watch over the safety of her eggs, to bring back those which incline to float off, to repair breaches in the fragile nest, or support a sinking portion by a fresh bubble of air. In about seventy hours the eggs begin to manifest motion, when the father breaks down the central dome, retaining only the circular floating-wall as a barrier against the escape of his offspring. For the next four or five days his life is a hard one, fully occupied in chasing after the constantly scattering fry, until they become so active as to convince him, reluctant, that he may as well give it up. M. Carbonnier relates the history of three different layings, of about 150 eggs each, and tells so lively and almost romantic a story of these humble aquatic loves that the reader can not but sympathize with the anxious carefulness of this excellent husband and father.—*Bulletin Hebdomadaire.*

FISH CULTURE IN MASSACHUSETTS.

THE tenth annual report of the Fish Commissioners of Massachusetts is full of interesting matter, besides containing a general review of fish culture in the State, and for the past ten years in particular, written by Thomas Lyman, chairman of the commission. The report says that the fish-ways throughout the State have generally proved successful, especially those over high dams. The great difficulty has been to find the kind of way best suited to shad; a question rendered more than usually difficult by the fact that shad do not return above their own spawning-ground; and as all shad above the high dams were destroyed long since, as the female shad do not return to spawn until about three years old, and as those shadlets put in above the dam are hardly old enough yet to return, no fair test has yet been obtained of the efficacy of the shad-"ways." Especially is this true on the Connecticut River and at the Holyoke fish-way. But as several shad passed freely through this way last year, its efficiency is established, and all further efforts there will be directed toward making improvements about the entrance of the way and to putting the shadlets in the river above the dam, so that their natural instinct will lead them to seek the upper waters of the river for spawning. This fish-way is the only one built over any considerable height of dam where shad are positively known to have passed. The salmon-way at Turner's Falls is nearly completed.

In the remarks upon trout culture, great stress is laid on the fact that large and stagnant ponds are not favorable for trout, as the water becomes too warm for the health of the fish; owing to this reason, many attempts at trout-raising have failed. About 250,000 salmon were hatched last year, from spawn received from the Bucksport (Me.) establishment, and distributed in the head-waters of the Merrimack. A large amount of land-locked salmon spawn will be received from Maine next year; over 75,000 California salmon have been hatched from 80,000 eggs received from that State, and have been distributed through the State. Last year about 5,000,000 young salmon were sent from California to the Atlantic States, besides 2,000,000 placed in rivers in that State. For the completion of the Lawrence fish-way, and for improvements of the one at Holyoke, the commissioners recommend an appropriation of $3000, and $5000 for other expenses of the Commission. The total expenses of the Commission, last year, was $6061. Among the ponds leased, last year, was Lake Pleasant, in Montague, to that town, for ten years; there are 55 leased ponds in the State. E. H. Kellogg, of Pittsfield, for the lessees of Pontoosuc Lake in that town, reports that 400 or 500 land-locked salmon were placed in it in 1874, that they are doing well, and that the leasing of Pontoosuc Lake will result greatly to the advantage of the public. The report of Assistant United States Commissioner J. W. Milner, who superintended the shad-hatching at Holyoke last year, shows the following disposition of the young fishes: Connecticut River, from Smith's Ferry to South Vernon, Vt., 1,205,000; at fishery, 580,000; streams in New-England other than the Connecticut, 320,000; started for Germany, 400,000; rivers in the United States other than New-England, 530,000; total, 3,035,000.

The sketch of Mr. Lyman, in speaking of the increase of shad by artificial propagation, says: "In the Connecticut River a marked and, so to speak, special result has been obtained. The average of the fisheries for 1864 to 1869 was only two fifths of that from 1827 to 1836, and each year showed a rapid decrease. Suddenly, in 1870, the river was filled with shad! There had been no such take for a generation before. And so, in the main, it has since continued; the season of 1875 having been the best one in 20 years."

LIQUID GLUE.

THE following preparation of liquid glue has been recommended. Dilute phosphoric acid with two parts by weight of water, and saturate it with carbonate of ammonia. The liquid, which must still be acid, is to be diluted with one part of distilled water and warmed in a porcelain vessel on a steam bath.

Dissolve in it so much Cologne or Flemish glue as to produce a thick syrupy solution. Glycerine and sugar syrup are to be avoided, as they render the glue gelatinous again. The liquid glue must be kept in bottles carefully closed.—*Industrie-Blätter.*

LESSONS IN MECHANICAL DRAWING.

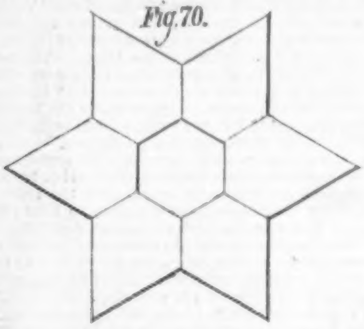
By Prof. C. W. MacCord, Stevens Institute.

Lesson VI.

(Continued from page 185.)

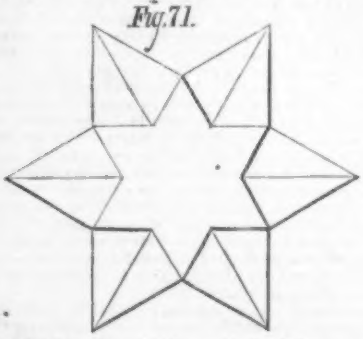
It is proper, before proceeding, to call attention to an accidental omission in Lesson III. We gave there two forms of drawing pens, Figs. 26 and 27, and it should have been stated, that this was for the purpose of showing more clearly the difference between a good shape and a bad one. Fig. 27, then, represents the form which a pen ought to have, and Fig. 26 a form which is too common, but ought to be rejected. We stated that a pen in proper condition will work best when held, like the pencil, as nearly in a vertical position as may be, and that method of holding it, as illustrated in Fig. 6, Lesson I., also enables the user to terminate his lines at the

Fig.70.



right point with greater certainty. Now, Fig. 27 shows a pen in which the point is in a line with the axis, and the inner blade, that is, the one next the ruler, is almost straight, as nearly so as the necessary taper on the outside will permit it to be made. This enables the draughtsman to hold the pen more closely against the ruler, and gives it a better bearing against its edge; and the advantage of this form over the one shown in Fig. 26, in which both blades are curved, is so decided that we unhesitatingly recommend those who have pens so made, to have the inner blade straightened at the earliest opportunity. In this, as in many other things, points of difference which are apparently quite minute are practically of considerable importance, and many such as this are not spoken of at all in the treatises on drawing instruments and their uses. We call attention also to the curvature of the outer blade, which is such that the two blades recede from each other quite rapidly near the point; the object of this is

Fig.71.

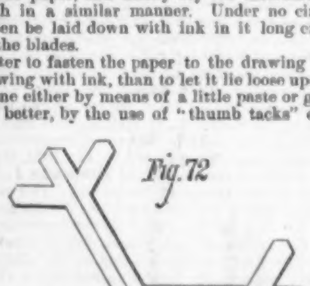


that a greater quantity of ink may be held there—were the outer blade made with a flatter curve toward the point, the thinner film of ink thus retained would evaporate with greater proportionate rapidity, rendering it necessary to clean and refill the pen more frequently, causing needless waste of time.

It should also have been stated that the pen should be carefully cleaned after as well as before using it, which is best done by passing between the blades a bit of paper, folded and moistened, the screw being so adjusted that the blades press firmly on the paper, and finally dry the instrument with paper or cloth in a similar manner. Under no circumstances should a pen be laid down with ink in it long enough for it to dry on the blades.

It is better to fasten the paper to the drawing board or table in drawing with ink, than to let it lie loose upon it. This may be done either by means of a little paste or gum at each corner, or better, by the use of "thumb tacks" or drawing-

Fig.72



pins. The latter consist of a steel pin, screwed and riveted into a thin flat head of brass or German silver.

There are good and bad forms of even so small articles as these: the former is shown in Fig. 28, the latter in Fig. 29. The pin itself should be cylindrical for the greater portion of its length, and the head should be slightly convex on the top, in order that the squares and rulers may slide easily over it, as well as *very* slightly bevelled on the lower edge, so that it may be removed with reasonable ease. A very common and very bad form is shown in Fig. 29; the pin is conical, which causes it to quit its hold on the slightest provocation, and the steep bevel of the head obstructs the motion of the ruler.

It may be added, that the process of what is called "damp-stretching," by wetting the paper and pasting the edges to the board, will be explained in due time; but that we do not recommend it, except in making large and elaborate *pictures*, or when a drawing is to be tinted with the brush. Not only for elementary exercises such as those we are now giving, but for all ordinary "working drawings," the drawing-pins are not only the most ready and convenient, but the best, means of securing the paper upon the board.

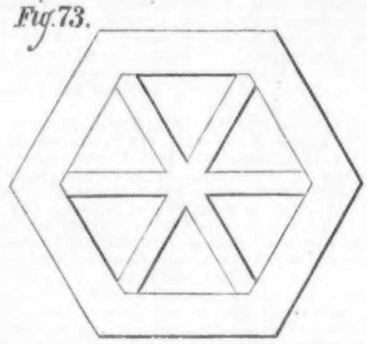
Lesson VII.

We have not yet exhausted, by any means, the variety of work which may be executed with the triangles alone; but before presenting additional examples in proof of this and for further practice, there are two or three reasons for describing some other instruments.

In the first place, as we have already stated, although these things can be done without anything more than what has been explained, yet they can be drawn more rapidly and therefore more satisfactorily by the use of other appliances. We do not mean hereby to retract one word of what we have said as to the importance of a thorough mastery of the simple implements with which we set out; on the contrary we repeat with emphasis, that next to the scale, the triangles are by far the most useful parts of the draughtsman's outfit, and that skill in handling them is one of his most valuable accomplishments.

But they do not enable him to draw curves; and whether we confine "mechanical drawing" to its application in the drawing of machinery or not, circular arcs present themselves at every turn, and the constant repetition of straight-line exercises alone may grow monotonous. It is time too, that

Fig.73.

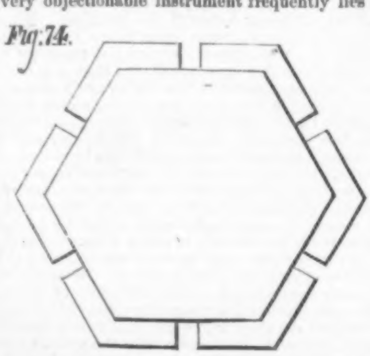


those of our readers who intend to go beyond these began to familiarize themselves with the means of doing so; and what is of still greater moment, the "laying-out" and checking of many of these very exercises, especially of those which like the snow-flakes are symmetrical about a central point, is much facilitated by the use of the compasses. Again, those who rely upon our hints in regard to the selection and purchase of instruments, may wish, as it would be advantageous to do, to procure at once all those necessary for such work as they may design eventually to perform. So that on the whole it seems better to describe the most essential of these now, instead of waiting until they become absolutely indispensable to further progress.

Now, "A Case of Drawing-Instruments" is a subject upon which a great deal has been written, much indeed that might better not have been. It may be said, "Why, there are plenty of instructions about all this; every one knows what a pair of compasses is, and any dealer will give us what we want." To which we reply, that a somewhat extensive experience has convinced us of quite the reverse; there are plenty of instructions, it is true, but they lack what the natural philosophers call "sharpness of definition;" it is not every one who knows what a pair of compasses *ought* to be, and many dealers will give you what you do not want, and may wish you had never seen.

However, the reader need not fear that we shall startle him by presenting *forms* radically different from what he probably has in mind; but the difference between a very convenient and a very objectionable instrument frequently lies in min-

Fig.74.



ute features, likely to escape the notice of one not thoroughly familiar with their use; and whether it be due to the lack of such experience or not, it is nevertheless the fact, that these are precisely the points in regard to which most if not all the published treatises are silent or deficient. As to the dealers, again, they naturally will sell whatever their customers will buy, and their shops are filled with an appalling array of glittering superfluities, as well as with imitations of good designs by makers who themselves fail to catch the exact point of excellence that they ought to copy.

When our readers become customers, we hope that they will be able to select just what is needed, that they will be under positive conviction as to the superiority of one thing to another, and able to give good reasons for the faith that is in them. We therefore give careful drawings of instruments which have been proved perfectly adapted to their purposes by years of constant use; and we call particular attention to the circumstance that these drawings represent not merely the general form and arrangement, but the exact proportions and dimensions, of these instruments. And this with a definite purpose and a good reason. The peculiarities of *style* are to a great extent matters of taste; the English, the German and Swiss, and the French instruments all have pronounced characteristics of style, and diverse opinions will of course exist as to the comparative beauty of these, nor is it abstractly of any consequence. But there are peculiarities beyond this, which are of consequence; for instance, the Swiss and German instruments are almost always excessively heavy. This not only makes them appear clumsy but it is a positive disadvantage in use, and a very decided one. The first thing to be noted as a desideratum then is, that every instrument should be as light as it can possibly be, without impairing the necessary rigidity and freedom from springing, whatever the style.

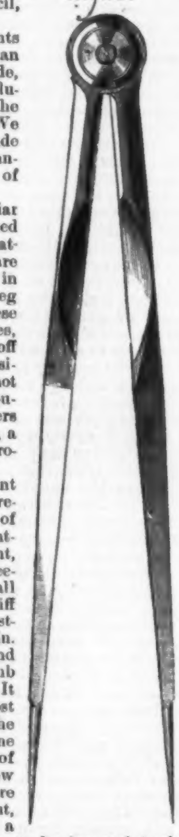
We shall now assume that the reader intends to pursue mechanical drawing in application to machinery, and he will naturally and properly wish to know what to get, in order that he may execute the most work, in the best manner, with the least outlay. To which we reply, that a case containing besides the two drawing-pens previously spoken of, the pieces which we now illustrate in Figs. 75–79 will exactly fulfil the conditions. These are the following:

1.—5-inch Divider.

2.—4-inch Compass, 3 shifting points.

3.—1½-inch Spring-bows, Pen, Pencil, and Spacer.

Fig.75.



The drawings represent instruments of the English style, but lighter than the English ones are generally made, the reduction having been made gradually, till by a series of experiments the best practical limit was reached. We are aware that they have been made lighter, but also that the result is unsatisfactory, owing to the springing of the instruments in use.

The Divider, Fig. 75, is so familiar an implement that hardly a word need be said in explanation; but we call attention to the round points, which are far superior to the common form, in which the triangular section of the leg is continued to the very end. These points should be as sharp as needles, *and kept so*; their use is to mark off distances by pricking the smallest visible holes in the *surface* of the paper, not through its substance. And the popular impression that a pair of dividers may serve on occasion as a nut-pick, a drill, or a reamer, without gross impropriety, is wholly fallacious.

The upper part of the instrument may be of brass or German silver, preferably the latter, the points being of fine steel. In selecting, particular attention should be given to the joint, which should move with perfect freedom, certainty, and uniformity all through its range, and yet be stiff enough not readily to lose its adjustment if laid down and taken up again. The user should be able to open it and to adjust it accurately with the thumb and fingers of the right hand only. It may be added, that the best and most durable joint is what is called the *double* one, two plates of steel in one leg fitting in two slits of the metal of the other, the steel pivot having a screw on its outer end, so that the pressure may be adjusted by means of a flat nut, turned when necessary by means of a little key, which has two projections, to be inserted in the small holes shown in the nut in the figure.

The divider is used only for setting off or measuring distances and subdividing lines, either straight or curved, never for striking circles. For this purpose the compasses with shifting points are employed; in general form they resemble the divider, as shown in Fig. 76.

The joint by which the two legs are united is precisely the same, and should stand the same tests. But the legs themselves are very differently made. The one on the left, it will be observed, has a joint at about the middle of the length, and terminates not in a plain point but in a tubular socket, in which is held by a tightening screw what is called a needle-

Fig.76.

point. This is merely a bit of steel wire with a shoulder turned on the lower end, beyond which projects a very fine and sharp short point, which alone should penetrate the surface of the paper, the shoulder sustaining so much of the weight of the compasses as is necessary to make the point retain its hold, and no more. Thus when, as often happens, many circles are to be struck from the same centre, the point is prevented from wearing deeper and deeper into the paper, as it would do were the point merely tapered.

The upper end of the needle-point is thus tapered, if desired, so that by reversing it, and using the plain point A in the other leg, the compasses become a pair of dividers: or it may have another point like the lower one. In either case,

it is to be specially noted that the wire *fits the socket*, so that it is supported and steadied by it through the whole length of the latter; and the wire itself must be of fine steel, well tempered. A very common substitute is to put a common sewing-needle into such a socket; but the tapering form of the latter leaves it free to spring, it being held only at one point, where the screw presses on it; it is, therefore, by no means as good a device.

The right leg of the compasses is made in two parts, the upper one being jointed to the other leg, and furnished at the lower end with what is known as a "bayonet-joint." This consists of a socket, formed by drilling a hole in the end of the piece, and afterwards slitting the tube thus made lengthwise on the outside of the leg, thus permitting the sides of the socket to spring slightly. The upper end of the remaining part of the leg is first turned cylindrically to fit the tube, and then fitted with a feather on the outside, which enters the slit, and being very slightly tapered, wedges itself firmly in, and is thus securely held.

Three pieces are thus fitted to this socket, namely: a plain leg, A, like that of the divider, a pen-point, B, and the pencil-point shown in place, whence the name, "compasses with shifting points;" so that with the same instrument we may

Fig. 77.

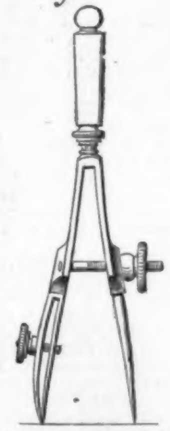
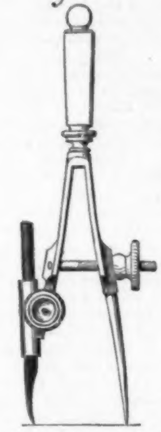


Fig. 78.



draw circles in pencil or in ink, or by reversing, if desired, the needle-point and using the plain leg, we have a second pair of dividers, which is often desirable.

Each of these movable points, it will be observed, is provided with a joint like that in the fixed leg; all these joints should move smoothly, but quite stiffly, the object being to enable us to set both the needle-point and the pen or pencil perpendicular to the paper. The necessity of this is obvious: if the leg at the centre be inclined, it describes a cone in turning round, thus tending not only to ream out a large hole in the paper, which of itself is bad enough, but making it almost a matter of certainty that the exact centre will be lost, if more than one or two circles be drawn. The pencil-holder consists of a steel tube brased to the lower end of the leg, the whole being split longitudinally and fitted with a binding screw, thus forming a very neat and firm clamp. Formerly the size of this tube varied at the fancy of the maker, and it was intended to hold a common drawing pen cil, which the user had to whittle down and file or scrape to fit the clamp more or less accurately, at the expense of much loss of time and temper. Fortunately this trouble may now be saved, the clamp being made to fit the instrument leads introduced by Faber, which are of all grades of hardness, but of uniform size and quality. Should the contingency ever

Fig. 79.

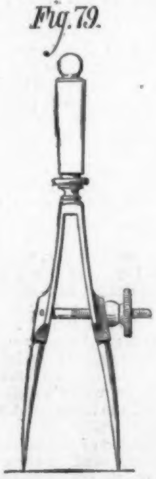
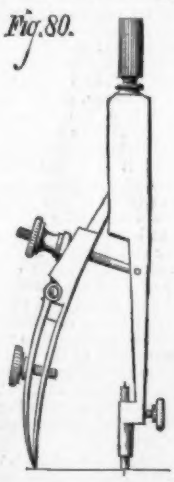


Fig. 80.



arise that these can not be procured, it is only necessary to split off the wood entirely from the common cedar pencil, and use the lead alone in the clamp. The latter is set on the leg at a slight angle, as shown, and the tube should be of *steel*, as stated, in order to combine strength with lightness.

A very common and very useless addition to the compass is a "lengthening bar," which is merely a bar of triangular section corresponding in style and finish with the other parts, and fitting at one end into the socket of the leg; the other end is provided with a similar socket to receive the points. Thus the range of the instrument is increased, the addition of the bar enabling us to describe very large circles. But unless the whole compass is so heavy as to be exceedingly clumsy and objectionable when used without the bar, it will spring and tremble when used with it. If therefore any one has it in his case, we advise him unhesitatingly to throw it away and put another drawing-pen in its place.

Now, this "bayonet-joint" appears to be peculiar to the English style of instruments; in the others we have mentioned, the shifting points are secured in the sockets not by a feather and slit, but by means of a binding screw, like that of the needle-point in Fig. 76. In order that the points may not turn in the socket, the latter is made square or triangular. The objections to this device are that the socket must be made heavier; that the binding screws, being frequently used, are likely to wear loose; and that the points can not be changed as rapidly, time being lost in screwing and unscrewing, and should the user chance to forget to tighten the piece properly, the point will shake in the socket or may fall out. Without laying any stress on this last point, we say without hesitation that the neatness, lightness, and convenience of the bayonet-joint make it most decidedly superior to any other device for the purpose yet introduced.

Dealers and makers will say that "it requires such nice fitting." Well, if that be an objection, it can not be gainsaid; it *does* require to be well made, and is worth the trouble, too; if they say in addition that it is likely to wear loose, the reply is that if it does, that is the fault of bad workmanship; the instrument whose portrait we give in Fig. 76 has been in use fifteen years, and is as good to-day as when first finished.

Now, for smaller work we need smaller instruments, and the "spring-bows" shown in Figs. 77, 78, 79 are expressly adapted for the accurate drawing of very small circles, and the setting off or subdivision of minute distances. The two legs, instead of being jointed together, are made of one piece of steel, the elasticity of which keeps them apart; the radius is adjusted by means of a screw, pivoted to one leg, and passing through a hole in the other, this hole being large enough to accommodate the side motion of the screw due to the varying angular positions of the legs. A milled nut on the screw presses against the outside of the leg, as shown; and it ought to have a spherical termination, resting in a corresponding cavity in the outside of the leg, so as always to bear fairly against the latter in the manner of a ball-and-socket joint. These instruments are each fitted with a short handle at the top, of metal, ivory, or ebonite, as they are altogether too small to be used like the compasses.

The pen-bow, Fig. 77, has the pen of the general form given in Fig. 27; and we again call attention to the peculiar curvature of the outer blade, which is such as to have as great a volume of ink near the point as may be, so that evaporation will not render refilling and cleaning necessary so often as if the blades were close together in that region. This is specially important in this small instrument; it is frequently necessary to draw a great number of very small circles, as for instance in a plan showing the riveting of iron-work, and if they are no larger than pinholes, which is often the case (and they can easily be drawn, with the instrument shown in the cut, of $\frac{1}{16}$ of an inch diameter), it is hardly possible to clean and refill the pen without opening the legs, which renders a readjustment of the radius necessary; and when time presses, it makes a material difference whether this must be gone through with once in five minutes or once in ten; the form of the pen is therefore more important in this instrument than in any other.

Again, this form of the spring-bow reduces the weight to a minimum. Any one who has done much at a time of such work as that above mentioned (especially on tracing-cloth, when the instrument has often to be turned round two or three times before the pen will mark properly on the glazed surface, on which the ink does not always flow readily) knows that it made his wrist ache, no matter how light his bow-pen was, and we hope to save any one who may have it to do from that annoyance so far as may be, by cautioning him against the Swiss and French monstrosities shown in Fig. 80, which, aside from their preposterous weight and supreme ugliness, are so bulky as to hide a great deal more of the work than they should.

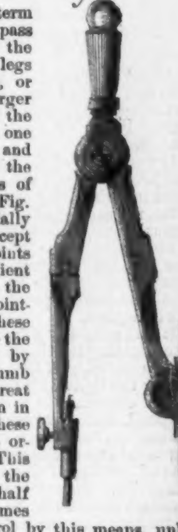
The clamp of the pencil-bow is made to hold the same lead as that shown in the compasses, and the pipe or barrel of the clamp should be at least three-eighths of an inch long, in order to hold the lead securely. What is just as important is that it should not be extended so far as to leave less than three-eighths of an inch of the lead projecting. Because, for drawing the finest and smallest circles, the lead should be cut slightly concave on the inside, as shown, and convex to a slight degree on the outside; this can not be done readily if the free end be shorter than here stated—and if it could, the point would be too blunt for the ready and accurate drawing of such fine work. Makers and dealers may try to convince purchasers that so long a point is apt to break; to which we say that it will not break of itself, and there is no good reason why it should be broken, nor will it be if used properly.

These little instruments should be made of the finest steel and well tempered. In selecting, care should be taken to test the strength of the spring in the legs by drawing a few circles with the pen and pencil-bows, with as large a radius as possible; there should be no tendency to trembling under a moderate pressure: sometimes it happens that the upper part of the leg is made too thin, the spring being thus too light, which renders the instrument unreliable and a little worse than worthless; and it is evident that the spacing divider ought to be equally stiff.

The instruments above enumerated and described are those which will enable their possessor to execute the greatest range of work with ease and precision that can be done with so few pieces. The four-inch compass will readily work down to the range of the spring-bows, which one of a larger size will not do; the attempt to draw very small circles with a large instrument will be found very unsatisfactory. And in the other direction its range is so great, and it is so convenient in the handling, that it is by far the most generally useful instrument of its class that we have ever seen. Of course the professional draughtsman will require larger compasses, and other instruments which we shall describe in due time. But these should constitute the nucleus of his outfit; for however large and complete it may be, he will probably find that more than half his work will be done with those above mentioned. And we would advise all who may design eventually to procure a larger assortment to secure these at all events, of the best quality their means will warrant, and to add others afterwards from time to time as circumstances permit. In so doing they need not fear any lack of uniformity in style, as fortunately these things can be made here. Though the shops are full of imported work, yet when it comes to the best quality, we have never seen any instruments, be the same French or English, German or Swiss, that could equal in design, surpass in finish, or underbid in price the best of those made in America.

It will be understood, of course, that we are now speaking to those who intend to do a considerable amount of mechanical drawing, whether they devote themselves to it professionally or not. To them we say that in the long run the best is the cheapest, and it is far better to expend a given sum in the purchase of a few well-selected instruments of the best quality than in buying a greater number of inferior ones. The element of durability is too often lost sight of: we have known draughtsmen literally to use up a set of showy instruments in a comparatively short period, and find them very unsatisfactory in use while they were about it; whereas with the exception of the pens, which will wear, a set of well-made ones will do good service for two generations of draughtsmen. We say, then, that double-jointed instruments, of steel and German-silver, are the best and most durable; however, single-jointed ones of brass and steel if well made will do efficient service; but let the purchaser be particular about the fitting of the joints; for if they are badly made he will regret the outlay, be it ever so small.

Fig. 81.



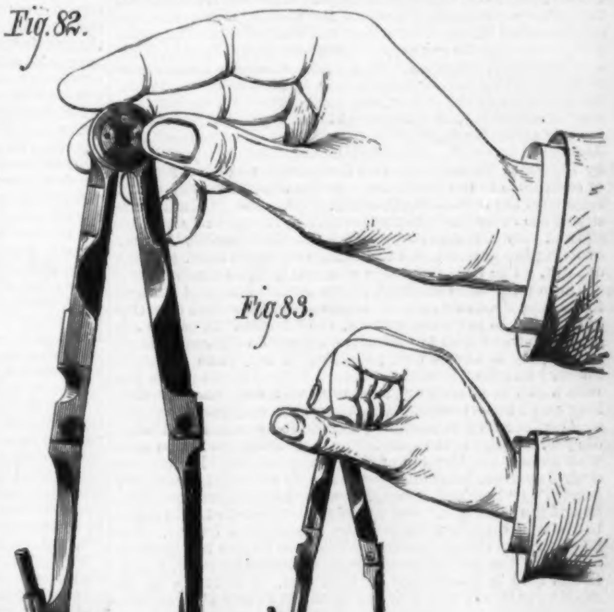
Now, it is proper to say that the term "bow" is applied to a small compass fitted with a handle at the top like the ones above described, whether the legs be made of springs, as in these, or jointed together like those of the larger compasses. In the latter case the handle is usually made of metal, in one piece, with a jaw which passes over and grasps the joint, the screw-pivot of the latter extending through the sides of this jaw. Such a bow is shown in Fig. 81, the construction being substantially the same as that of the compass, except that instead of having shifting points it is usually thought more convenient to have two, one with a pencil and the other with a pen, both legs being jointed, as in the figure. In regard to these it is to be noted that they are, like the spring-bows, manipulated simply by twirling the handle between the thumb and finger. This looks like a great advantage over the compass shown in Fig. 76, or over the divider, as these require some considerable skill in order to manage them properly. This is true up to a certain limit: if the legs be much over two and a half inches long, the instrument becomes too heavy to be under good control by this means, unless it be so very light as to spring and tremble in handling. It is possible, although we are by no means sure of it, that a circle may be drawn more quickly with a *compass* which has such a handle than with one which has not; but accuracy in mechanical drawing is a more important thing than speed, and for any thing larger than the size named this handle is simply a nuisance. A pair of jointed bows (pen and pencil) two and a quarter or two and a half inches from centre to point might properly form a part of a very complete outfit for a professional draughtsman; but though it seemed appropriate to describe them here, we will add that they are the part that can most readily be dispensed with, since the four-inch compass will do all that they can very nearly as readily, and much more.

Also, it is to be remarked that the spring-bows are made of various sizes, but it is not worth while to have any that are more than an eighth of an inch shorter than the ones illustrated; nor is it well to have them very large, as a great range is not desirable on account of the time required to adjust them. If a case contain two sets, one might be an inch and a half, the other two inches, in length, the larger ones having needle-points like those of the compass. These needle-points are of advantage when, as in some line-shading, a great number of circles very close together are to be drawn, the radius being not too small. For minute circles the needle-point is rather in the way. By minute we mean here any thing less than an eighth of an inch in diameter: and unless there are quite a number to be put in concentrically, the draughtsman ought to handle the instrument so lightly as not to require a needle-point at all.

And finally, in speaking of the dimensions of instruments, we may say with reference to the compass that one larger than five and a half inches is too cumbersome, as if stiff

Fig. 82.

Fig. 83.



enough not to spring it will be very heavy. These are usually made, in the Swiss and German cases, with *both* legs fitted with sockets, a pair of plain points, a needle-point, a pen, a pencil, and a lengthening bar—that is to say, six movable pieces; and it is not unusual to see a three-inch compass, with a handle at the top like a jointed bow, with the same pieces attached except the bar. All this makes a fine show and fills up the box; meanwhile it will be observed that we are given screw-joints all round, as being cheaper than the bayonet-joint. Now, were the useless pieces left out, the material and labor thus saved would fit the useful ones with the better joint, and leave the maker a fair profit, as the draughtsman would gladly pay the same amount for his more compact and convenient case with three movable pieces to each instrument. If our judgment be worth any thing, the 5½-inch compass can not be improved, if it be precisely the same in construction and substantially the same in proportion as the four-inch one shown in Fig. 76.

(To be continued.)

THE ILLUMINATING POWER OF GAS.

At the meeting of the Institution of Civil Engineers, London, 15th of February, Mr. George Robert Stephenson, President, in the chair, the paper read was "On Estimating the Illuminating Power of Coal-Gas," by Mr. William Sugg, Assoc. Inst. C. E.

It was observed that, notwithstanding the attention which had been bestowed upon the subject, gas photometry was still in an unsatisfactory state. With even the most perfect apparatus, the same quality of gas was differently estimated in different places, because there was no generally recognized standard burner. The jet-photometer, originally invented by the late Mr. George Lowe, M. Inst. C.E., had been so improved that it was possible to ascertain, by simple inspection, the true illuminating power capable of being evolved from different coal-gases.

It was generally acknowledged that the most accurate way of estimating the illuminating power of gas was by burning a known quantity of that gas in a standard burner, and comparing the light with that from a known quantity of oil or sperm consumed in a certain kind of lamp or candle. In England, since the year 1852, the parliamentary standard of comparison had been a sperm candle, of six to the pound, burning at the rate of 120 grains per hour. But the average normal rate of burning of these candles was nearer 130 grains than 120 grains. Therefore it was desirable that the parliamentary standard rate should be altered, if a change could reasonably be made. The greatest obstruction to the adoption of a uniform system of gas photometry had always been the difficulty of settling the kind of burner with which the gas should be tested. With the standard quantity of the same gas, different kinds of burners gave different results; and the same burner gave different results with the same standard quantity of gases of different illuminating powers, richer or poorer, according to the kind of gas it had been orginally designed for. In 1863 Dr. Letheby designed, in conjunction with the author, a standard burner with a 15-hole incorrodible steatite top. Previous to this all testing burners had iron tops, which were subject to alteration by oxidation. This burner, known as the "Sugg-Letheby" 14-candle burner, was one of the parliamentary standard-testing burners for 14-candle gas, and was used, with a chimney 7 inches long and 2 inches wide, in England, in some parts of North and South-America, in Canada, Australia, and New-Zealand. There were, however, two other parliamentary burners for 14-candle gas, namely, one described in the Birmingham and Staffordshire Gas Act of 1864, for testing the gas supplied to Birmingham, Hanley, Hull, and, till lately, Brighton. The other 14-candle burner was that adopted by the gas referees for London in 1869. It was the invention of the author, and was known as Sugg's "London" standard Argand burner for 14-candle gas, and it was used for testing the gas supplied to the city and other parts of London by the Gas-Light and Coke Company, by the Imperial, and by the South Metropolitan Gas Companies, and by a number of companies in the provinces. It was also the new standard burner for the Dominion of Canada. The same standard quantity of the same quality of gas tested by these three burners showed very different powers of light, the "London" burner evolving the greatest, and the Birmingham the least, amount of light. The total difference was nearly three candles.

There were three different parliamentary standard burners for testing 16-candle gas, all to consume the standard quantity of 5 cubic feet per hour, namely, the "Dublin" 16-candle Argand 15-hole steatite top burner, used with a chimney 7 inches long by 2 inches wide; the Dublin flat flame 16-candle burner; and the "London" standard Argand for 16-candle gas with a 24-hole steatite top, to be used with a chimney 6 inches long and 2 inches wide. There was but one parliamentary standard burner for consuming 5 cubic feet per hour of 18-candle gas, namely, that described in the Leamington Gas Act, which was a modification of the "Sugg-Letheby" burner, the central aperture being enlarged to supply more air to the richer gas. The "London" 18-candle burner for the standard quantity of the same quality of gas gave an amount of light equal to about 2½ candles more than the Leamington burner. For 20-candle gas the parliamentary standard burner had been described by the gas referees as Sugg's steatite batwing, No. 7. It was used in London and in Liverpool. For 27 up to 32-candle gas it was customary to make use of any kind of fish-tail burner, and to consume any quantity of gas, at the option of the operator. For cannel gases there was no regularly authorized parliamentary burner.

By the system of the author, one standard burner only was proposed for all qualities of gas from twelve to thirty candles. This burner might be readily gauged and verified by actual trial against the Government standard burner. It was the gas referees' London Argand burner, with a chimney 6 inches or 7 inches long by 1¾ inches wide, producing a flame always 3 inches in height; in fact such a burner as was ordinarily adopted by consumers. When used with 16-candle gas it would burn 5 cubic feet per hour with a 3-inch flame, the light from which would be equal to that given by sixteen sperm candles of six to the pound. The quantities of different qualities of gas required to produce in burning a 3-inch flame with this burner, were with

12-candle gas	....	6.6 cubic feet.
14 "	....	5.7 "
16 "	....	5.0 "
17 "	....	4.7 "
18 "	....	4.4 "
19 "	....	4.2 "
20 "	....	4.0 "
25 "	....	3.2 "
30 "	....	2.7 "

Eight different sizes of "London" Argand burners were shown, which gave *pro rata* amounts of light for different quantities of gas, varying from 2½ feet to 7½ feet per hour.

Of late years a gas referees' standard burner had been constantly used by the author as a standard light for testing various kinds of gas-burners, and it had been found that the illuminating power as well as the appearance of the 3-inch flame had been always constant, notwithstanding considerable variations in the quality of the gas. The proposed method for effecting a comparison was as follows: The gas referees' 3-inch flame burner having been fixed on a photometer in the place usually occupied by the standard burner, it was lighted, and allowed to burn off all the dead gas collected in the meter and fittings of the apparatus. Then a clean chimney was put on, and the height of the flame regulated by the aid of the usual micrometer cock and King's pressure gauge to exactly 3 inches. The quantity of gas per hour required to give this flame was then found, and a reference to the table would show the examiner the illuminating power of the gas. The rest of the experiment was performed in accordance with the instructions of the gas referees, and would be a corroboration of the table, and at the same time a check upon the accuracy of the sperm candles, which were very subject to error. The result was the illuminating power of the gas in terms of the parliamentary standard quantity of 5 cubic feet of gas and 120 grains of sperm candle. Every quality of gas tried upon this system would be fairly consumed, and a like quantity of gas would be designated by the same number of candles of illuminating power.

The paper was illustrated by diagrams and an actual specimen of a new and simple apparatus, the invention of the author, termed an "Illuminating Power Meter," by which the illuminating power of gas could be read off from a dial at once in standard sperm candles. No previous knowledge, either of the manufacture of gas, or of its chemical composition, or of the mode of testing it, was requisite for the use of this novel instrument.

ACTION OF LIGHT ON SELENIUM.

Mr. W. C. Siemens, D.C.L., F.R.S., gave, at the Royal Institution of Great Britain, a recent "Friday evening discourse" on the action of light on selenium. In his introductory remarks Mr. Siemens referred to the fact that, while Newton laid down incontrovertible principles regarding the nature of light, it has been reserved for physicists of recent times to prove the effect of light upon solids. One of the most beautiful illustrations of the permanent effects of light upon solids is furnished us through photography. Another effect is rendered visible by phosphorescent salts, which, when acted upon by light, continue to glow in various colors for a length of time when taken into a dark room. Last week only, at the same institution, Mr. Crookes had shown experiments illustrating the mechanical action of light on solids. It is, too, light that breaks up the carbonic acid in the leaves of plants in order to separate the carbon. Carbonic acid may be broken up by heat; but at a temperature of 2500 deg. C., which would destroy all vegetable organization. The influence of light on selenium makes known another action—an action which regulates the extent to which it is an electrical conductor. The history of the discovery is briefly this. Mr. May, a telegraph clerk at Valencia, noticed that a stick of crystalline selenium, such as had been used for some time in telegraphy where high electrical resistance was required, offered considerably less resistance to a battery current when exposed to light than when kept in the dark. The facts were made known by Mr. Willoughby Jones in 1873, but there for a while the matter rested. The statement was received with some incredulity. Could it be possible that the mere superficial action of light upon a solid substance could so change instantaneously its internal condition as to open among its particles flood-gates for the passage of the electric current, to close again upon the removal of the light? The question has within the last twelve months been made the matter of independent inquiry by Dr. Werner Siemens in Germany, and Professor Adams in England. By different methods these two observers have arrived at results which agree in most points of fact, though they somewhat differ in the deductions they draw from them. Selenium, an elementary body discovered by Berzelius in 1817, is placed by chemists in the border territory between metals and metalloids, and it does not seem to be amenable to the laws governing either of these natural groups. If melted it presents a brown amorphous mass of conchoidal fracture, which is a non-conductor of electricity, but if a stick of this amorphous selenium is exposed for some time to the heat of boiling water it assumes a crystalline fracture, and when again inserted in the galvanic circuit it is found to be a conductor of electricity. Some experiments were shown of the action of light by a contrivance of Dr. Werner Siemens, in which the selenium under examination was in a form in which the surface action produced by light can produce its *maximum* effect. Two spirals of thin wire (iron or platinum) are laid on a plate of mica in such a way that the wires lie parallel to one another without touching. While in this position a drop of fluid selenium is made to fall upon the plate, filling the interstices between the wires, and before the selenium has had time to harden, another thin plate of mica is pressed down upon it so as to give firmness to the whole. The two protruding ends of the spirals serve to insert this selenium element in a galvanic circuit. Mr. Siemens calls this disc his "sensitive element." The whole arrangement is no larger than sixpence. Its action was shown in this way: It was placed in a galvanic circuit, at one end being a Daniell's cell, and at the other a delicate index galvanometer. The "disc" was first inclosed in a dark box; the circuit was "made," but no electricity passed through—no movement of the index was seen. The "disc" was then exposed to light; still no action was apparent. Another disc was taken that had been kept in boiling water for an hour, and gradually cooled. In the dark box it gave a slight passage to electricity as indicated by the index, but as soon as the light was admitted the index registered a great passage of electricity. Another disc heated to 210 deg. C., and allowed to cool, was then used, and a greater action still was apparent with this. Dr. Werner Siemens has worked at the meaning of this, but without tables and diagrams it is not possible to convey an adequate idea of his results. The basis of the change in condition seems to lie in the fact of the extent to which the selenium is heated, for when again allowed to cool its behavior depends on the extent to which it has been heated. The experiment was shown of the effect of different parts of the spectrum on a disc. The actinic ray produces no effect, but the influence increases as we aproach the red end. A selenium photometer was also shown in action, the principle of which is to compare the relative effects of two lights in effecting the conditions for the passage of electricity. At the end of the lecture a most interesting little apparatus was put at work, which Mr. Siemens calls a selenium "eye." There is a small hollow ball, with two apertures opposite to each other. In one is placed a small lens, 1½ inches in diameter, and at the other a "disc." The disc is connected with a Daniell cell and a galvanometer, and this represents the retina. There are two slides, which represent the eyelids. The action of light on the disc is indicated on the galvanometer. Not onyl was this shown to be sensitive to white light, but sensitive in different degrees to different colors. Mr. Siemens suggested it would not be difficult to arrange a contact and electro-magnet in connection with the galvanometer, in such a manner that a powerful action of light would cause the automatic closing of the eyelids, and thus imitate the spontaneous brain action of blinking the eyelids in consequence of a flash of light. To physiologists this analogy may be suggestive regarding the important natural functions of the human frame. —*London Times.*

[Iron.]

GOLD-WASHING AT YESSO, JAPAN.

Professor Munroe gives an interesting account of the Japanese method of gold-washing, which he says is far more efficient in saving fine gold than the cradle or "long tom," and which he consequently adopted for testing the auriferous gravel His tests ranged from one fourth of a cubic yard to two or three cubic yards each (and it would be probably safe in saying that a cubic yard of the gravel would weigh about a ton).

This is the method of washing: A washing ditch, 2 or 3 feet wide and 20 feet long, is formed by clearing out the bed of a small stream or walling off a portion of a bed of a larger stream. Riffles of flat stones are placed at its lowest end. The gravel is shovelled into the head of this ditch, and the workmen throw it out by hand or with the aid of the hoe and the *kua*, a scoop-shaped bamboo basket. The clay and finest sand are washed away by the current, leaving in the stream the fine gravel and gold. When this deposit has become about 1 foot thick, the washing begins, on straw mats especially woven for this business, which seem to serve the same purpose as the hides of the Mexican gold-washer or the coarse blankets manufactured for stamp-mills, tailing-sluices, etc., on the Pacific coast. The manner of their use is peculiar.

Two or three mats, each 1 foot wide by 2 feet long, slightly narrower at the lower end, are placed side by side across the stream, about 2 feet below the upper end of the gravel. The upper edges of these mats are buried slightly in the gravel, and held in position by the foot of the gold-washer, usually one man to each mat, the number of mats being regulated by the width of the stream. These men now carefully hoe the gravel to the head of the mats, so that it shall be carried on their surface by the force of the current. The heavy gold and iron-sand sink between the thick twisted strands of straw forming the mat, while the lighter gravel passes down stream. The lower ends of the mats are from time to time lifted, and folded over the upper portion, to transfer the gold to the head of the mat, and to keep the lower part clean.

When all the gravel in front of the mats has been hoed over their surface, the men move them about 2 feet down stream, and begin to work in a similar manner on the new portion of gravel thus exposed. Finally, after twenty-five to thirty minutes' work, the mats are removed, one by one, from the bottom of the stream; folded in both directions under water, to transfer the material to the middle; and then bent in a trough-like form, and "jigged" with a longitudinal motion, under the water, to separate the lighter sand and gravel which still remain. One of the mats is then held in the stream, between the ankles of the gold-washer; folded lengthwise as a trough, through which the water is allowed to flow quietly. A second mat is then seized by the ends, inverted, and folded transversely, the fold being allowed to dip just below the water in the trough of the mat below. The mats are so woven that this folding opens the crevices between the large transverse strands, allowing the gold and iron-sand to be washed out by the water. By alternately raising each end of the mat, while depressing the other, the whole surface is successively washed by the stream; and the various strands of the mat being opened and loosened by the folding, the gold and iron-sand are very completely transferred to the lower mat. In a similar way, the concentrated material from all the mats is collected on one; and from this is finally transferred to the shallow wooden washing-board. This last transfer is made with great care, in a quiet pool of water, in which place the final concentration, on the board, is effected. The separation of the gold from the iron-sand, on this board, requires great care and skill. The board is first floated on the water, and by a few oscillating motions the material is washed to the centre. Then it is raised from the water with a number of smart longitudinal jerks, the effect of which is to bring the heavier material to the end next the gold-washer, while the lighter sand flows off gradually with the water at the lower end. The board is now brought to the surface of the water the lower end dipping a little below, and with one or two gentle swings it is again covered with water, while a small quantity of light sand is washed from the lower end. The board is now raised with the same dexterous shakes as before, the washing being conducted with great care, and but little iron-sand being allowed to pass off each time. After five or six minutes most of the gold will have been brought to the head of the board, the bright yellow grains showing very distinctly in the black sand. The gold may be brought more clearly into view by allowing a little water to trickle down the incline board, which washes off the black sand, and leaves the gold exposed.

This first portion of gold, with some of the adjoining iron-sand, being removed, the remaining sand is then washed a few times, usually yielding one or two grains in addition.

Finally, the gold and the small quantity of iron-sand taken from the board at the same time, having been dried, are submitted to a careful separation by blowing; the iron-sand is carried off, and the gold remains, ready for weighing. In this last separation a small magnet is sometimes of assistance in removing large grains of iron-sand too heavy to be blown away.

The manipulation of the *ita* or warped board described in the above paragraph is closely similar to that of the wooden *batea* of the Mexicans—the forerunner of the California iron pan. The *batea* contains considerably more material than the ordinary Russia-iron prospecting pan, and may perhaps work faster, but, in spite of the talk in its favor which we hear now and then from those who have been bewitched by the dexterity of the Mexican, it is inferior to the pan for saving fine gold. Nor can it be so easily cleaned of grease or quicksilver—an operation which, in the case of the pan, is quickly performed by simple heating. We presume these remarks are equally applicable to the Japanese *ita*. As to the *nabota* or straw mat, we doubt its superiority to hides or blankets. The Japanese system, as a whole, appears to be a capital one for prospecting. In continuous operations, sluices, riffles, and quicksilver would doubtless be as efficient and much cheaper and more rapid.

[Manufacturers' Review and Industrial Record.]

EOSINE.

THIS latest addition to the list of artificial dye-stuffs presents so many interesting points, both on account of the manner of its preparation and its peculiar characteristics, that we present herewith a full account of what is at present known about it.

Eosine may be classed with the coal-tar colors. Although it differs entirely in the mode of manufacture from the aniline and naphthaline colors, and from artificial alizarine (which have been heretofore comprised more especially under that appellation), the two substances which form the starting-point of its preparation, *phthalic acid* and *resorcine*, may be obtained directly from coal-tar hydrocarbons. Phthalic acid is the final product of the oxidation of naphthaline, and resorcine, which was originally obtained by the action of caustic potash on *assafœtida* and other resins, is now manufactured by the distillation of dry benzol sulphate of potash, which in its turn is derived directly from benzole.

In 1871, Adolph Bæyer published a series of highly interesting researches which led him to the discovery of a number of new coloring matters known as "phenol dye-stuffs," and which are considered by many as pointing out the most promising road toward the artificial preparation of the tinctorial principles of many dye-woods, lichens, etc. Among other results, he found that by heating anhydrous phthalic acid and resorcine together at 195° C., a new substance was formed, which he called *fluorescine*, on account of the strong and beautiful green fluorescence exhibited by the red solution of this substance in ammonia. Zinc-dust, acting on an alkaline solution of substance, gives rise to a new colorless body, which was called *fluorescine*.

Dr. Caro continued the investigation of this substance in connection with Prof. Bæyer, and showed that by treatment with bromide, fluorescine is converted into still another new substance, which has the characteristics of an acid. It is of a brick-red color, insoluble in acids and water, but readily soluble in alkalies, with a beautiful red color in transmitted, and a greenish-yellow color in reflected light. The solutions, even if very dilute, show a magnificent fluorescence. The neutral potash salt of this substance is the new dye-stuff to which the name eosine has been given, from the Greek word *Eos*, the dawn.

Prof. A. W. Hofmann, the discoverer of the aniline colors, says in regard to this name: "Thus far the color industry can boast of no great accomplishment in framing names, but in this instance a good name has really been produced for once." There can be no doubt that this is the finest red color that has yet been produced. At first it seemed doubtful whether it could be produced cheap enough for industrial application, and the first specimens offered about a year ago cost more than $100 per lb.; but by successive improvements in the manufacture, it has been gradually cheapened, and it is already offered in the market at such a price that it can be used on silk and the finest classes of woollen fabrics.

Debierre gives the following *résumé* of its properties in a late number of the *Bull. de la Soc. Ind. de Rouen*:

"Eosine occurs as a reddish-brown powder, with metallic reflection; when evaporated from its aqueous solution, it has an appearance exactly resembling uncrystallized fuchsine. The water solution is strongly fluorescent; by transmitted light it has a yellowish-pink color, and by reflected light it is green.

"This substance is soluble in water, ethylic and methylic alcohols, alkalies and alkaline carbonates, glycerine and soaps; it is insoluble in ether, phenic acid, aniline oil, or benzine. It is very soluble in water; 100 parts of cold water dissolving 40 parts eosine, and boiling water dissolves 45.4 parts. Its aqueous solution smells strongly of bromine when boiled. It does not dissolve so largely in commercial alcohol, requiring 11 parts of it to dissolve 1 part of eosine. It is a very powerful coloring matter; 1 part in 250,000 of water gives a fine pink color, and one part in a thousand million times its weight of water gives a pink tint, discernible in a thickness of a few centimetres.

"Eosine, which, as we have said, is a potassium salt, is decomposed by most acids, which give an orange-red flocculent precipitate, especially in strong solutions; it is decomposed by acetic acid, but the liquid remains of a pink color, on account of the slight solubility of eosine in that acid.

"Nearly all the soluble metallic salts give lakes with eosine; the brightest are those of tin, alumina, and lead, which are of a fine red with a yellowish hue. Zinc gives a more yellow lake; silver and mercury give purple lakes; and copper a brownish-red lake.

"These lakes are somewhat soluble in water, especially in calcareous water, which probably decomposes them, reproducing eosine with a lime basis.

"This new coloring matter dyes silk, and wool, and all animal matters, easily, by simply immersing them in a water solution of the color. The characteristic yellow reflection of eosine is not permanent upon silk, and only visible in light shades. Dyeing in cold solutions gives brighter shades than dyeing in hot. . . . .

"Notwithstanding its high price, it can be economically applied in silk and woollen printing, for its great power enables it to give a very good pink, when used in the proportion of one part to one thousand of thickening (70 grains or about ½ oz. to the gallon). It is printed upon silk by simply thickening with gum-water, and fixing in the ordinary way. Upon wool it is employed either by printing or dyeing.

"All the attempts to obtain a fast color from it upon cotton have failed. It does not dye or fix with the usual mordants, as tin, tannin, alumina, iron, glycerine, and arsenic, or caseine; it fixes with albumen, but loses its beauty, whether dyed by means of it, or applied as a steam color. If cotton be padded with a solution of eosine, slightly thickened with gum, and then passed into a solution of acetate of lead, and some other metallic salts, it forms very bright lakes, which might be serviceable for some styles such as linings.

"The lakes thickened with albumen give but dull colors; if the lakes are dissolved in ammonia, thickened, and then printed upon cloth prepared in different ways, the resulting colors are loose, and wash off.

"Eosine can, however, be fixed in various manners upon cotton, but whatever method be employed, if the colors were left in running water of a calcareous nature, the color is almost totally washed off.

"The various ways by which the color can be temporarily fixed are as follows:

"1. Arsenite of alumina added to the thickened solution of eosine, and printed upon cloth prepared with tin, steamed and washed.

"2. Mix a solution of eosine, with its equivalent of acetate of lead, acetate of tin, or acetate of alumina, thickened; print upon calico either prepared with tin or oiled, steam and wash. Upon oiled calico the shades are bluish.

"3. The best method is to prepare the calico with solution of glue or gelatine, print on a mixture of eosine with three times its weight of tannin, steam and wash."

"Prof. Bæyer gives the following test for eosine in solution, which involves some remarkable color reactions. If a little eosine is shaken with sodium amalgam, and gently heated at the same time, the red liquid becomes colorless, the eosine being reduced to fluorescine. If this is diluted with water and a drop of permanganate of potash solution added, the colorless liquid becomes opaque green in reflected light, the fluorescine being oxidized to fluoresceine.

Eosine in solution may be distinguished from fuchsine, coralline, and saffranine, by dilute sulphuric acid; fuchsine and coralline give a yellow, saffranine a violet color, eosine an *orange precipitate*.

To distinguish eosine on the fibre from other red dye-stuffs, Reimann recommends a solution of sulphate of alumina (alum ?) in four parts of water. All other red colors are removed from the fibre when treated in this hot solution, but eosine red remains almost unaffected.

R. Wagner recommends collodium as a means of distinguishing eosine on the fibre from aniline colors and alizarine red. The fabric is moistened with a drop of collodium; if a white spot appears, the coloring matter is eosine.

Already we hear of adulterations of this new dye-stuff, starch being reported to have been found in several samples. Alcohol of 95 per cent will dissolve the eosine, and leave the starch or sugar, if present behind, as an insoluble residue.

Prof. Bæyer, with a number of his friends and students, are still engaged in further researches on this and other kindred dye-stuffs alluded to in the beginning of this article, and we should not be surprised soon to hear of discoveries no less interesting than that of eosine.

ROSOLIC ACID.

DISSOLVE 17¼ ozs. of rosaniline, or a corresponding amount of one of its salts, in a mixture of 2¾ pints of concentrated spirits of salt and the same measure of water. The brownish yellow solution is filtered and diluted with about 262 pints of water. A diluted solution of nitrate of soda is then slowly added, with constant stirring, till the rosaniline has almost, but not quite, disappeared. To ascertain this point a drop of the mixture is thrown from time to time upon filter-paper, and its outer margin is observed as it spreads. As long as rosaniline is present a red margin is perceived, and the addition of the nitrate of soda is continued till this reaction is only just distinct. The liquid is then gradually heated to boiling, and when the violent escape of nitrogen gas has ceased, it is rapidly filtered. On cooling, tolerably pure rosolic acid separates out in fine shining, green-brown crystals.

These are dissolved in caustic soda for purification, and the solution is saturated with sulphurous-acid gas. The deep red solution is decolorized, the impurities are separated as dark-brown red flocks, and, on adding a mineral acid to the filtrate, which is nearly colorless, and heating gently, rosolic acid is separated in a very pure state. It dissolves very readily in hot alcohol, less freely in the same solvent when cold. It is tolerably soluble in glacial acetic acid and in ether, but insoluble in benzol and sulphide of carbon. It is scarcely soluble in water, but more readily in acids. The solutions have a yellowish-red color. In alkalies it dissolves with a red color, which in thin layers appears of a bluish red, but in bulk takes a yellowish tone. It does not melt at 518° Fahr., and if heated more strongly it forms a bulky charcoal, whilst water and phenol escape. Rosolic acid has the character of a very feeble acid, and does not readily form definite salts. If ammonia is passed into its alcoholic solution, the ammonia salt is separated out in the form of steel-blue needles. It is very sparingly soluble in alcohol, dissolves readily in water, and if exposed to air or washed with water, the ammonia gradually escapes. The baryta and lead lakes are also decomposed by washing. The best method of testing rosolic acid is to dissolve it in hot alcohol, and then add an aqueous solution of bisulphite of soda. If the solution becomes colorless, and no resinous matter separates out, the rosolic acid is pure.—*Liebig's Annalen.*

SULPHUR AS A MORDANT.

MR. CHAS. LAUTH has recently published the contents of a sealed package which he deposited in June, 1872, with the Société Industrielle de Mulhouse, and in which he announces the very interesting discovery that finely divided sulphur, in the form in which it is precipitated by acids from solutions of hyposulphites, forms an excellent mordant for methyl green. The wool is mordanted with 3 grammes sodium hyposulphite and 2 grms. sulphuric acid, dissolved in 600 grms. of water and dyed in a bath containing 0.2 grms. methyl green, 0.6 grms. zinc acetate, 0.6 grms. sodium hyposulphite, and 600 grms. water. To obtain a yellowish shade, 0.07 grms. picric acid may be added. The zinc acetate is used in order to counteract the effect of the sulphur mordant, which makes the wool soft and shrinking. A committee appointed by the Society, and consisting of Messrs. Schaeffer and Vaucher was charged with the examination of the matter, and their report confirms the observations of Mr. Lauth.

"It seems to us interesting to determine," says the *Industrial Record*, "whether sulphur would act in a similar manner with other dye-stuffs, and we selected eosine for the experiment. Some sodium hyposulphite was added to an aqueous solution of eosine in a test tube, and after the addition of a few drops of hydrochloric acid, the liquid was *neutralized* with ammonia. After standing a short time, a veritable lake of sulphur and eosine settled to the bottom as a rosy-pink precipitate. We next dyed a piece of woollen fabric, following the directions of Mr. Lauth, as above, only substituting eosine for methyl green, and omitting the acetate of zinc. The result again showed that sulphur acts as a mordant for eosine, and the resulting shade is somewhat different from that obtained by omitting the sulphur, as shown by a simultaneous dyeing test."

This result induced us to test the behavior of wool, mordanted with the sulphur, towards madder. The bath was prepared in this and subsequent experiments in the proportions already described, only the dye-stuffs being changed, and the zinc acetate omitted. A "swatch" from the same piece, but not mordanted, was placed in the dye-bath at the same time, in order to facilitate comparisons.

In the bath prepared with French extract of madder, the mordanted wool took a full reddish brown shade, while the non-mordanted cloth was but lightly stained. To decide whether this color was due to the alizarine or to turpentine, samples of mordanted and clean wool were treated in baths mounted with artificial alizarine on the one hand, and with commercial purpurine on the other.

The samples from the alizarine bath were alike, and dyed a good yellow; those from the purpurine bath showed a light reddish-brown, the color of the mordanted sample being deeper than the other. We therefore conclude that sulphur does not act as a mordant towards alizarine, but does act in that manner towards purpurine or the other coloring principles of madder.

We extended our experiments to cochineal, logwood, redwood, and fustic; but in the case of these dyestuffs, we discovered no great difference between the colors produced on ordinary and sulphur-mordanted wool.

PENCILS OF NITRATE OF ZINC.

PENCILS and cones of nitrate of zinc, which have come into use of late for cauterizing purposes, may be made as follows: Dissolve good commercial zinc (Lehigh) in nitric acid (sp. gr. 1.200), until the latter is saturated; separate the solution from the undissolved zinc, and while still warm, add one part of precipitated carbonate of zinc for every thirty-two parts of zinc in solution. The carbonic acid of the carbonate of zinc is transferred to the iron, which contaminates the commercial zinc and is present as ferric nitrate, and an additional quantity of nitrate of zince is formed; the heat, however, causes the decomposition of the ferric carbonate, the carbonic acid escapes, and ferric oxide, together with the excess of carbonate of zinc, is deposited. Filter the solution, which must be considerably diluted with water to prevent it from tearing the filter, and evaporate it on a sand bath until it appears as a quiet, fused mass, but yet liquid. Should the evaporation have been conducted too far, which is indicated by the escape of yellowish fumes, the vessel should be removed from the fire, allowed to cool, and a quantity of very dilute nitric acid added, after which it is again to be evaporated to the proper point. This fused liquid, which must not be so hot as to ignite paper on which a few drops have been allowed to fall, is poured into paper moulds about four inches in length, made by rolling paper around glass rods or lead pencils, pasting the edge and closing the bottom. No oil or fat of any kind must be used, as the paper will invariably take fire in this case. When the sticks are hard they are inclosed in glass tubes, and the latter well corked. For use, a small quantity of the paper is removed from one end by means of a knife, and, if desired, the end of the pencil may be pointed.

NEW MAXIMUM AND MINIMUM THERMOMETER.

THE activity with which deep-sea explorations have been carried on of late makes the want of a good and cheap minimum thermometer more keenly felt. M. Duclaux recently communicated to the French Academy of Sciences a new principle for the construction of maximum and minimum thermometers. He has found by experiment that two liquids can be mixed together, of such a nature and under such circumstances, that on a change of temperature they immediately separate from each other, one resting on the other with a sharply defined surface between them. The chemical composition of the two liquids remains precisely the same after the separation as before, and only their relative volumes are altered. The same result occurs if three liquids are mixed, when, as is generally the case, the third has no influence on the separation of the other two, and remains at the same degree of concentration in each of the two separate layers as in the original liquid. The only difference is that the third liquid modifies the molecular relations of the other two, and renders them soluble in each other, thus serving as a bond of union between them. They still separate, when the original equilibrium is destroyed, into two layers, between which the third liquid is uniformly shared.

For example, a mixture of 15 cubic centimetres of amylic acid, 20 of ordinary alcohol, and 32.9 of water, though clear and homogeneous above 20° C., becomes thick and separates into two layers on reaching that temperature. Similar mixtures, containing more or less water, would give the same result at other temperatures. They may be very easily prepared by taking the required quantities of amylic and ordinary alcohol, keeping them at a fixed temperature, and adding water, drop by drop, till a slight thickening is observed, which can be dispersed by the slightest addition of heat. The mixture being put into a tube, which is closed by fusion in a lamp, will always thicken and separate into two distinct layers on reaching the temperature at which it was made, and nothing but raising the temperature or violent shaking will make them unite again. The distinction between them may be rendered still more evident by adding to the original liquid a few drops of red ink or ammonical carmine, which colors the whole liquid as long as it continues homogeneous, but is concentrated in the lower layer, leaving the upper almost colorless as soon as separation ensues.

Instruments made on this principle have the disadvantage of requiring a special mixture for each temperature; but they are easy to make, cheap, and strong enough to bear shocks and pressure, and are well suited for sea-soundings. They may also be of use in rooms, hot-houses, and wherever it is of less consequence to know the temperature with precision than to prevent it from falling below a certain degree. *Comptes Rendus.*

COTTO CYLINDERS

A SUBSTITUTE for the ordinary cylinder covered with cloth and leather has been adopted by M. Osgood. It consists of the adoption of gelatine or other like substances treated with such matters as the bichromates, and dried in a moderate heat. The material thus obtained is reported to possess great resistance and tenacity, and, of course, there is no seam to injure the slivers, while the electricity is less than in the ordinary cylinders. Moreover the exact degree of electricity required may be obtained by the addition of more or less glycerine. Another great advantage claimed for these composition rollers is that they are worked with much less power than the others. The inventor says that he has obtained excellent results by the following method. He dissolves 200 parts of gelatine in 600 parts of hot water, and then adds 100 parts more water, containing a solution of seven parts of bichromate of potash and 100 parts of glycerine. The roller is cast in a mould, in the centre of which the axis of the cylinder is fixed, the mould being well oiled. The ends of the composition are dressed, and the cylinder dried at a temperature of 18 deg. to 20 deg. centigrade. The drying occupies from three to six days, at the end of which time the cylinders are fit for work. When very hard surface is required, the glycerine is omitted altogether, and for very soft cylinders the quantity is increased. Glue, treacle, or other like substances may be substituted for gelatine. When the surface is required to be rather rough, so as to nip the fibres more firmly, a sufficient amount of gum or resin is added to the composition. The invention reminds one of the rollers which made such an extraordinary revolution in printing.

THE VITI OR FIJI ISLANDS.

THE occupation—or as the word is—annexation of the Fiji Islands, by Great Britain has attracted the attention of the world to that archipelago. Previously to the formal act of cession by the chiefs, the islands had been largely colonized by English and American adventurers. The leaven of the latter was discernable in the newspapers, published at Levuka, in which were given specimens from time to time of that special American industry, "Constitution" making. Other articles of news and of editorial comments, political appeals, and views of correspondents, showed that the islands were seething with the Anglo-Saxon-American uneasiness and activity. King Cakobau the last of the line of Fiji kings was evidently nonplussed, and amidst proclamations, legislation and other mysteries, "all a muddle" to the native mind, scarce knew where he was. He solved the difficulty by the surrender of his sceptre to the English in the autumn of 1874, and since then appears to have vanished from the public view.

Previously to his abdication, his dominions had been largely invaded by the white race. The smaller islands of the fertile group found most favor with single proprietors and with companies. On these islets they employed native labor in "gangs" of from twenty to hundreds; raising cotton of a quality said to compete with the "Sea-Island;" coffee, sugar, and other tropical products. The commerical capital of the Fijis, Levuka, is on the island of Ovalau, which will be found near the centre of the map. Outside of the consular establishments, Levuka has missionary buildings and many churches and schools. It has from fourteen to twenty hotels constructed of wood, and shops of all sorts, including "Magazines des Modes." Two photographers, and certainly one newspaper, if not more, flourish there. The view of the city which accompanies this article is engraved from a photographic picture. The situation is picturesque. The buildings are crowded upon a plain on the sea-shore, backed by wooded mountains. The abundance of the verdure, the cocoa and other palms with banner-like leaves waving above the rest of the tropical growth, embowering the houses, make the buildings of Levuka look to the observer like objects *cut in*, or inlaid in an emerald ground.

The ceremonies attending the reception of the English ambassador had a mingled air of the curious, the grotesque, and the sad. On the parade ground a company of native soldiers presented arms, under command of a white officer (we might say European, if there were not ten chances to one that he was a Yankee). They were uniformed with blue jackets, like those worn by the Chinese, and had the native uniform in addition, of a white cloth about the loins. Their military drill was executed with a very respectable precision. At intervals parties of men and women, in a costume little advanced beyond that of Eden, passed rapidly, bearing fruits and delicacies of the native *cuisine* to the house of the king, these supplies being in answer to the royal requisition.

In the costume of the islands King Cakobau looked "every inch a king," and would have served for a statue in ebony. In his interview with the English envoy he bore himself with great dignity and self-possession, and made it apparent that he was flattered by a visit from the representative of Queen Victoria.

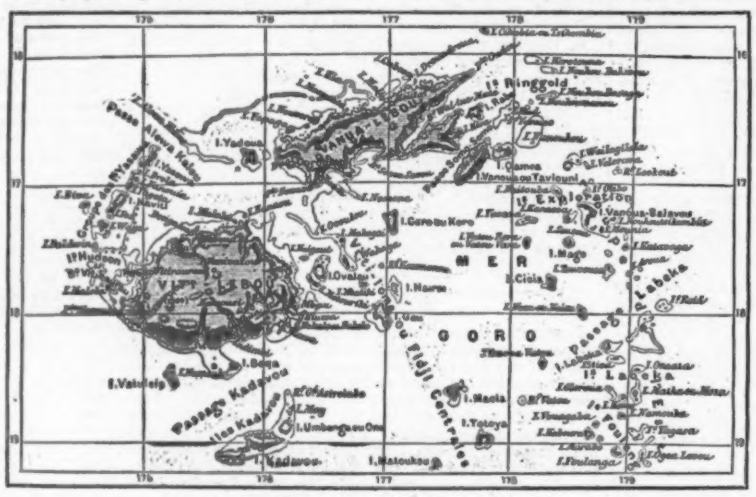


CHART OF THE FIJI ISLANDS.

[Detroit Tribune.]

THE AMAZON AND ITS ANTIQUITIES.

THE regular monthly meeting of the Ann Arbor Scientific Association was held February 5th. The attendance was larger than usual, the attraction being the lecture announced to be given by Dr. Joseph B. Steere, who has been travelling in various parts of the world for the past five years. The speaker took for his subject "The Amazon and its Antiquities," and spent the main portion of his time in explaining the ancient pottery which he collected from the vicinity of this great river, and which he has deposited in the museum of the University. After noticing the peculiar character of the valley of the Amazon and how unfavorable it is for civilization, he said he had reason to believe that there lie buried far beneath the surface of the earth relics and proofs of the early existence of a people now entirely swept out of existence. He found the island of Marajo, at the mouth of the river, low and wet and covered with numerous mounds of earth, which were evidently thrown up by the inhabitants to get a dry place to live on. These are oftentimes an acre in extent, and on digging into them they are found to be filled with pottery, and, what is of special interest, burial-urns from two to three feet high. He had made some collections of these, but they were all broken on their way to this country, through the inquisitiveness and carelessness of the custom-house officers. Skeletons and hatchets were also discovered in these mounds. As he passed up the river the principal relics found were different kinds of pottery, from the rudest cooking bowl to the most elaborately finished drinking-pots. The latter are made almost invariably to represent some animal or fruit, and all are covered by an ingenious and entirely unintelligible marking. He endeavored to learn what this marking meant, and was finally told by an old woman, who was busily engaged in the work, that it represented the "Mother of Waters." Her work was very well in comparison with that on the ancient pottery, and she acknowledged that she could not do it as well as her ancestors, but claimed that she could far excel her daughters. The art of making these drinking-pots seems to be entirely lost. The plain vessels which are now made can stand no comparison with them. They are made entirely with the hands, by pressing together strips of clay from six to eight inches in length, which have been previously prepared. Mr. Steere gave interesting accounts of a number of ruins which he visited, of nicely-constructed walls of stone, in which no mortar is used, but with the parts fitting so closely that not even a knife-blade can be inserted into the spaces; of peculiarly constructed towers, with a broader top than base, rendering their scaling by an enemy impossible, and he told how he had discovered skeletons packed away in the walls. In Peru, west of the Andes, where little rain falls, and the sand is consequently very dry and deep, there are innumerable skeletons sticking here and there out of the earth. The land seems hardly to have furnished room for the dead of this once prolific people. These skeletons are shunned by the natives, except on St. John's day, when they turn out *en masse* and dig for relics. Vaults containing from twenty to thirty bodies sometimes are numerous, and while he was once exploring Mr. Steere said, he struck with his crowbar the stone slab which covered one of these vaults and which had never been opened since those who laid the dead away closed it. He found the bodies wrapped in cotton-cloth, and with each one was a pair of small tweezers, a pound of lime, and a pouch of cocoa-leaves, the two latter being used for food. There are also found in the vaults, pots of corn, peanuts, beans, etc. Some of the corn said to have been taken from one of these pots was brought to this city some months ago and deposited in the museum. The idea was conceived, after a time, of planting some of the grains, with little expectation, however, that they would grow, but this a lady member of the association had done, and the result is a stalk some eight or ten inches in height at the present time. This corn was exhibited to the association. Mr. Steere thinks that the history of the Peruvians has never yet been written. He considers Prescott's account of them as contained in his Conquest of Peru, made up of a tissue of lies which the Spaniards knew well how to fabricate. The only true record of this people lies buried in the relics beneath the surface of the earth, and in the few inscriptions which remain on stones and which are rapidly disappearing.

[Nature.]

INDIAN SKIN-SCRAPERS.

A REMARKABLE feature of the common Indian relics found in central New-Jersey is the very great abundance of "skin-scrapers," as one form of stone implements is everywhere known; and the great care that has evidently been bestowed upon them in the making equally attracts the attention when a series of these implements is examined. That a flint implement used in the preparation of skins for clothing and tent-covering should require as much care in its manufacture as an arrow-point, does not seem probable, and one would naturally expect to find in a scraper simply a comparatively dull rubbing edge given to a conveniently sized pebble. Such, however, is seldom or never the case, and the class of implements, to which is given the above name, are as marked in their several peculiarities as in any form of stone implement with which we are familiar.

VIEW OF LEVUKA, FIJI ISLANDS.

FIG. 1.

FIG. 2.

Having remarked the great abundance of these relics, I desire here more particularly to notice several specimens which are of more than ordinary interest. The illustrations 1, 2, 3 and 4 are figures of the very smallest scrapers that I have seen; and what is more remarkable that their small size is the beauty of their finish and their symmetry. They are made of differently colored jasper, were not found together nor in the same neighborhood showing that they had different origins, and are not examples of the fancy of some eccentric chipper of flint implements, such as sometimes occur in masses of broken specimens and flakes that indicate the former site of an arrow-maker's labors.

Not one of these four small scrapers appears to be simply a flake, originally of this shape and subsequently chipped at the scraping edge; but the entire surfaces have undoubtedly been carefully wrought, and show that a small mass of the mineral has been worked to the shape and finish of the specimens, as now found. A quite common form of scraper is the base of an arrow or spear-point that has been utilized by subsequently chipping the fractured end, so as to give it a bevelled edge; but the specimens here figured cannot be classed with these, inasmuch as there is nothing suggestive of the arrow-point in their shape, and unlike them, these four specimens have the under side smooth and slightly concave, a feature not found in the "made over" arrowheads.

Having seen that so much care was expended on these small scrapers, it is quite certain that these implements were put to some important use, but exactly what, it is difficult to determine. Certainly, in the dressing of the skins of our larger mammals they could be of no use, and of but little even when the skins of the smallest such as squirrels, were used, which was probably seldom the case, as the larger quadrupeds were easily obtained. The skins of birds, if used as ornaments would not need scraping to make them pliable; and I can only suggest that from the fact of having found traces of bone beads in graves made from sections of the long bones of wading birds I have thought it probable that these small scrapers were used in rounding off the ends of such bone beads, and they might also be used in the shaping and sharpening of the beautiful bone fish-hooks our aborigines were accustomed to make. Such uses would of course make the name "skin-scraper" inappropriate as I am quite disposed to think it is.

Fig. 5 represents a very perfect specimen of the spoon-shaped scrapers such as are common in Europe and by no means rare in the United States. These found here as a rule are not so symmetrical as the specimen figured and do not have the "bowl" or concave portion of the spoon so decidedly marked. Our New-Jersey specimens have this under-surface generally plain or but slightly concave, and uniform with the stem or handle of the implement. In the specimen

FIG. 3.

FIG. 4.

figured this is not the case and the spoon shape is so pronounced as to suggest that it is a veritable spoon.

Fig. 5 has been chipped from a very pretty agate pebble such as ocur in the gravelly bed of the upper waters of the Delaware River; and it is an interesting fact connected with this class of relics that the majority are made of jasper, agate and quartz, minerals the most difficult to shape and certainly no better adapted to the ordinary uses of these implements—that of scraping the fat from skins.

One word in conclusion. Mr. C. C. Jones, Jr., in

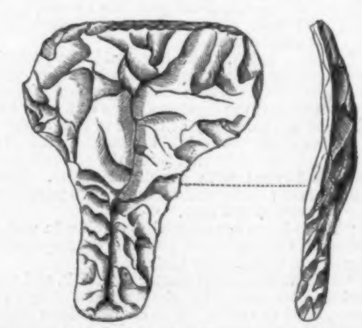


FIG. 5.

his work on the "Antiquities of the Southern Indians" writes under the head of "Scrapers" that "the spoon-shaped scraper of France and Switzerland is more pronounced in form and purpose than any implement of like character it has been my good fortune to find among the relics of the southern tribes."

It is curious that so much variation in the forms of their stone implements should exist in tribes nearly related, and but a few hundred miles apart. Judging from the specimens figured by the author quoted, scrapers were quite simple in their shape and finish; which as we have seen is the opposite of what we find in New-Jersey where as great variety in shapes and sizes occur as exist in the various patterns of arrow-point.

CHARLES C. ABBOTT.

Trenton, N. J.

IMPROVED ARTIFICIAL HORIZON.

MR. LANE, of the Coast Survey, announces that if in the bottom of the mercurial basin, near its edge, we cut a circular trough, such that the greater mass of the mercury may run into it, we may leave over the greater portion of the remaining bottom surface of the basin a thin layer of mercury, possibly the one-hundredth of an inch deep, which will not be troubled by the ripples that originate near the edges of the basin. It is easy, he says, by gentle taps upon the trough, to observe these ripples starting from the edge, but quickly dying out as they come upon the platena where the mercury is relatively shoal. It might be anticipated that a slight inclination of the basin would materially alter the horizontality of the surface of the mercury. He states, however, that this is not the case to any injurious extent, the momentary tilting of the mercurial surface being immediately followed by a resumption of its horizontality.